Are Executives to Join The Labor Turnover?

INDUSTRIAL unrest is ordinarily thought of as being perpetually epidemic in the "submerged tenth," and sporadic among laborers, mechanics and craftsmen. We hear much about this unrest—the former class furnishes fields where the police department's bomb-squad works, while organized labor furnishes the ever-present strikes and endless negotiations which receive such wide publicity.

Only since the profiteer has waxed fat has it dawned upon many that uneasiness is spreading wide among the men who wear white collars and work with their heads or nerves rather than their muscles. Only recently has it been recognized that a ferment is working among those conservative citizens who are often likened by the orator to the ballast of the ship of state, or other important, nice-sounding things. Whereas it was easy to see that large horizontal increases in wages had wiped out the differential which attracted the best workmen to the places demanding the most skill, effort and trust, it has only recently dawned upon many employers that there is a tremendous turnover in their staffs of clerks, technical men and unorganized skilled artisans. They seem to be driven from one place to another, more or less against their instincts, but really driven in the hope that their salary may somehow become larger so as more nearly to cover their necessities and leave a little for play and thrift.

But now it is going even higher up. As but one instance, general foremen in railway shops have had their salaries raised up to $300 a month, yet master mechanics, with very much greater responsibilities, still get unchanged their $325—by no means enough for a good executive under the present range in prices. More than a few of the faithful superintendents are wondering whether a period of service extending over their whole working years, a time in which they gave ungrudgingly the best there was in them to the untold profit of their employing corporation, is going to leave them poor at the finish. A director or manager is indeed blind if he can view the spectacle of common labor receiving two to three times what it got before the war, and the prices of all commodities correspondingly up, and yet assume that the wholly unusual men who are responsible for the success of the business are not going to be restive under the same old salary plus a 10 per cent bonus and with an occasional bouquet.

Under such circumstances nothing less is to be expected than that the most energetic men will leave their old positions and join the restive ranks which form the labor turnover. Expensive as the turnover is among the working force, it must be ruinous if it gets to the executives. BABSON, the statistician, was timely in his recent warning to stand-pat business to 'ware the new concern, which is recruiting talent among those who have already made good elsewhere. While we believe (more from that hope which springs eternal than from hard experience with the price-boosting activities of those who sell things) that the peak of high prices has passed, still that is no reason for further delaying that impluse to raise the salaries to where they were before the war. Then watch the efficiency curve!

Do We Need Immigration?

AGENCIES that are engaged in studying the labor problem in the United States are making public facts and figures that must give pause to executives in those industries in which a steady and uniform supply of labor is a vital factor. The chemical industries are not so much dependent on labor, perhaps, as are the metal industries, and yet when there is an actual shortage of manpower in the country as a whole, all industry must be affected. It requires no fine calculation to prove that there is an actual shortage of manpower in the United States, to say nothing of having a reserve that can be called upon in emergency. The steel industry, the railways, the telephone companies, the mills, factories and mines of the country are suffering from an acute shortage of workers; and to a large extent that shortage is in labor that formerly was supplied by immigrants from foreign countries. Nor is the shortage in unskilled labor alone, as a glance at the "help wanted" advertisements in the daily papers will attest. One authority has estimated that $30,000,000 was spent in 1919 for such advertisements in the United States alone—an eloquent testimonial to the competitive conditions that drove employers to extremity in hiring their neighbors' employees.

Labor leaders may assert that this is a desirable condition as far as the worker is concerned, for now there are more jobs than workmen. For general prosperity and healthful industry, however, the doctrine is as fallacious as the converse that there should be a great excess of laborers so that industry might bid the labor market down. Somewhere between lies the happy medium, with a sufficient reserve in manpower to meet emergencies. All of the capital in the country is not always profitably employed; no more is all of the labor likely to be. It is equally fallacious to assume that production is the only item to be considered, for while a labor shortage may enhance the value of a job, the market for the product is diminished by the reduced number of consumers. To put it concretely, if the labor resources of the United States have been reduced in recent years by 4,000,000 immigrants who normally would have come to this country if the

war had not intervened, we are not only short of their productive effort in industry but we lack the market for the consumption of commodities that those 4,000,000 men and their 2,000,000 women and children would have required. Add to this definite shortage of labor the loss in production due to strikes and the slackening in the productive effort of the average workman, and we have all the elements of a situation calling for study and an intelligent solution.

How shall we escape from this *cul de sac*? The Inter-Racial Council which has been recently organized, representing more than 450 industrial establishments, is of the opinion that the only way out is to adopt a plan of systematic and regulated immigration. They believe that immigration is more of an industrial problem than one of politics, and that a study should be made of its ethnical phases in order to encourage immigration of those races most easily assimilated and best adapted to our industrial needs. Their remedy comprises three elements: selection of immigration at the source, supervision of its distribution on its arrival, and adequate steps to assimilate and Americanize immigrants instead of leaving them to shift for themselves.

The program appeals to us as worthy of support. At present there is little discrimination in regard to the first two items. Immigrants come from practically the four quarters of the globe, and few are denied entrance. In the past the stream of immigration has flowed into this country at a few ports, and like the delta of a great river has spread out over a comparatively small and already congested area. As for assimilation and Americanization, the efforts have been largely local and in some cases spasmodic, although all that has been done is praiseworthy. What is needed is a co-ordinated plan that will consider the type and quality of the immigrant, his place in this country after he arrives, and finally a definite effort to accustom him to our institutions and make an American out of him. Immigration is needed to avert a continuous shortage of manpower, but it must be regulated and not be allowed to proceed promiscuously.

Why Not
Export Helium?

IT HAS been proposed, apparently in all seriousness, that we should establish an embargo upon the export of helium from the United States, in order to prevent foreign powers from accumulating a reserve supply for balloon-gas uses. We doubt very much whether this particular embargo will be given much serious consideration, but the principle involved in such matters should engage our most careful and serious attention.

Any natural resource of limited quantity that would be quickly exhausted and our own supplies thereby curtailed through export should be considered as being in a different class from materials such as helium which are being wasted unless developed and used currently. Helium is procured exclusively from the natural-gas supplies which are being developed and used for domestic or industrial purposes without regard to the helium content. If by maintaining a foreign market in such material we are enabled to exploit profitably this resource and develop the art of its recovery and handling to a satisfactory commercial state, we are attaining a very desirable position. Moreover, this

development and industrial advantage would be fostered largely at the expense of the foreign purchaser, and thus our industrial independence would be established with small cost to us.

There is little need to fear that helium or any other similar commodity difficult to store can be accumulated for use to our subsequent detriment. It does not lend itself to storage in quantity except at prohibitive expense. Thus, it is reasonable to assume that not more than a current supply will be maintained by purchasers abroad.

On the other hand, we should not be content to sell all of this material abroad, for if we do we may find ourselves in the unenviable position of knowing how to prepare a material but not knowing how to use it effectively. We should certainly hope to continue in this country a reasonable amount of industrial application in aircraft work and any other lines that may find this gas commercially applicable, so that we may keep pace with foreign development. Beyond this, however, we see no reason why the greatest facility for exporting such a commodity should not be afforded our industries.

The principles thus discussed apply in many other cases, though perhaps not as fully or as strikingly as to helium. It is worth while, therefore, to stop long enough in our consideration of international relations regarding each mineral or other natural resource, and think clearly as to whether or not continued production for export as well as continued development of the arts or application are receiving proper encouragement within as well as without our boundaries.

Empirical Equations in
Engineering Calculations

MOST, if not all, the formulas of physics and physical chemistry are in the primitive stages of a process of evolution. For example, take as a typical case the gas laws of BOYLE (MARIOTTE) and CHARLES GAY-LUSSAC), which form the very foundation of the study of not only gas phases but solutes as well. Later AMAGAT made a classical investigation in which he demonstrated that BOYLE'S premise that PV is constant for any given temperature is very inaccurate. Some time prior to AMAGAT'S publication of his nitrogen, hydrogen, ethylene and carbon dioxide $PV:P$ charts, VAN DER WAALS deduced a new gas equation, containing correction constants characteristic of individual gases. The generality of the VAN DER WAALS equation is only apparent and, not having great mathematical flexibility, it has not proved adaptable to a wide range of determined results in calculations to which it has been applied. While CLAUSIUS, DIETERICI and several others have devised more flexible mathematical equations, they have not solved the problem satisfactorily for the very simple reason that the premises they make are inaccurate, incomplete, or both.

In the case of steam, REGNAULT, BROCH, PEABODY, HENNING and many others have devised or revised the various empirical steam equations in PT that have been proposed since 1847. All these have, however, been too complicated to get into current engineering use. This, of course, is due to the fact that both the steam charts and tables are much more convenient.

There are cases in engineering where tables cannot be satisfactorily devised and empirical equations must be used. An excellent illustration is afforded of this

in the investigation of heat conductivity by GEORGE A. RICHTER, to whose paper on Double Pipe Heat Interchangers, published in this issue, the attention of the reader is directed. Mr. RICHTER has demonstrated the importance of film velocity, which has hitherto not been considered a factor of much weight. Problems of design require reliable guides in the form of tables, charts or equations of direct and specific applicability. To get this, theory has to take orders from an empirical superior. Deductions must be made on assumptions that have proved to be workable both forward and backward. Good empirical equations have an excellent qualification for workaday use by being based on data rather than a skeleton of simplified assumptions. The engineer is tending to make more use of them in his calculations and in time should derive better general equations than have hitherto been in vogue in theoretical science.

How Is an
Invention Invented?

LAYING down rules whereby an invention may be conceived is as hopeless a task as demonstrating by pure reason the existence (or non-existence) of GOD, Immortality, or the Infinite—which if we wanted to digress might all be argued to be the same thing. Pursuing the original thought, however, scientists are generally as different in their mental processes from inventors as philosophers are from theologians in this principal respect: Scientists and philosophers reach their conclusions by a skillfully constructed train of thoughts proceeding from cause to effect, while inventors and theologians arrive at their destination by an exercise of intuition.

This is probably most apparent in various aspects of religion. The Infinite evidently cannot be comprehended by the finite mind; It must be accepted meekly as an act of faith. Intuition may not so clearly be the main characteristic of an inventor. But if a scientist (bred in the bone) and an inventor (by divine right) both start from a certain point and travel in a certain direction they will proceed side by side closely in step until they reach a wide chasm, across which lies their goal. On the edge of this abyss the scientist sits down and starts to think. The inventor, however, lifts his eyes from the abyss, and seeing his destination on the far side, arrives there with one stupendous leap. That is to say, his leap is long enough if he is a successful inventor; others land just short of the farther bank and drop into oblivion!

And a curious thing about it is, that after the scientist sits and ponders and builds a substantial bridge of thought across the gap, he ultimately arrives at the same destination. But it is sometimes a long and discouraging task interrupted by as many false starts and failures as bridging the St. Lawrence. Meantime, if he ask his inventor friend how he did it, the inventor (almost prophet) speciously exhibits a phantom bridge as unsubstantial as a monkey-span across the great gray-green, greasy Limpopo. And the surest way for scientist and inventor to become estranged is for the former to point out the perfectly obvious faulty links and actual gaps in the chain of argument. As a parting shot, the prophet will exclaim against the obtuseness of men who are not awed by the unusual, saying: "Why are you so blind that you can't see it is thus and so?" Trying to justify a fact is so obviously foolish when you know it exists!

Therefore it is rather futile to give instructions to inventors who will find those real epoch-making things yet hidden far out into the dark unknown. But as a matter of fact, only an infinitesimal number of inventions belong to this class. The rest are merely adaptations of known principles, or an arrival at a given point in well-mapped territory by a less devious route. With such utilitarian things most modern seekers are concerned.

Perhaps the principal rule to adopt would be: Don't become discouraged because others have tried and failed. A sufficiently minute search through the literature would doubtless reveal at least one reason why any given scheme would be almost foolish. One or more men may have actually recorded failures in attempting the same path you plan to follow. But it would be as bad to turn back because some one else had not successfully traveled the route as it would to abandon the expedition in discouragement on arriving at the first obstacle. Still, don't become discouraged at the wrecks along the way!

A case in point is the recent development of a commercial process for electrolytic white lead by KREJCI and his associates. Electrolytic white lead is no new thing, as the *Transactions* of the American Electrochemical Society will bear witness. It had never been taken beyond the experimental stage, however, for a variety of reasons, but good practical technology (otherwise known as common sense) eventually solved the larger applications. Yet these men are frank enough to say that had they known of the failures of the earlier experimenters *before* their successful attempt instead of after, it is doubtful whether the trial would have been made.

A second rule follows from the principal one. If you are acquainted with the former work, and can see that it has all split upon one rock, rearrange the attack so as to turn the obstacle into a pronounced advantage.

The late WILLIAM THUM was fond of pointing out how this was accomplished in his now almost universally-used process for parting gold and silver. In all former experimentation it had been found impossible to refine gold bullion successfully in a tank, because the silver deposited from nitric acid solution would always (no matter what dodges were tried) deposit in a discontinuous mass of needles, which played havoc with electrical conditions and would not adhere to the vertical anodes. Yet, and it seems so simple that it took one of those flashes of genius to discover it, if the bottom of the tank were made the anode, the insurmountable difficulty of a non-coherent deposit became the chief advantage. Thus, in placing the impure cathode bars horizontally in the tanks, the loose crystals of pure silver collecting in quantity under the diaphragm at the bottom of the tank could be shoveled out quite easily.

Another simple illustration of the second point which comes to mind is concerned with matte casting. Those lead-plant men, who are used to casting matte buttons, know the difficulty and expense involved in breaking up the thick, tough slabs, to say nothing of the explosion risk when a partially-solidified mass breaks in handling. Yet if the liquid matte be purposely bled from the interior of such a button, the remaining shell will be safe to handle and will break with the utmost ease into the correct-sized material for re-charging.

Instances might be uselessly multiplied. After all is said and done, inspiration cannot be explained! But in directing it, the best captain is sound theoretical groundwork, and the best lieutenant is wholesome common sense.

Readers' Views and Comments

A Study of the Lime-Soda Ash Water-Softening Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having spent several years specializing on the purification of water for industrial purposes, the writer found the article by Max H. Herrle and Francis M. Gleeson, "A Study of the Lime-Soda Ash Water-Softening Process" (appearing in the Feb. 11, 1920, issue of CHEMICAL & METALLURGICAL ENGINEERING), quite interesting from a strictly laboratory standpoint, since they embody certain experiments the writer has never duplicated.

It would appear quite doubtful, however, if the authors of this article have any wide experience or knowledge of conditions met with in the evaporation of water for steam; for the reason that they fall into errors in drawing conclusions which indicate that the article is the product of analytical chemists without engineering experience.

In the first place, they divide the subject of water purification into three classes—distillation, filtration, and chemical purification by precipitation. Did they, in elaborating on these three classes, allow filtration and chemical purification by precipitation great enough latitude, this would be correct, but they limit filtration to the removal of suspended matter, and chemical purification to the use of some form of the lime-soda ash, the caustic soda, or the lime-barium water softener.

This excludes two widely used and well recognized methods of water purification—the zeolite method of water softening, and the use of boiler compounds.

Strictly speaking, the zeolite method of water softening is a filtration method, and for the benefit of Messrs. Herrle and Gleeson and any others who may not be acquainted with this method, I will give a very brief explanation of the process. A zeolite (as exemplified by Refinite, Permutit and Decalso) is a hydrated silicate of aluminum containing a large amount of sodium in a loosely bound condition. By what is known as the law of mass action, this sodium is exchanged for the calcium and magnesium in water percolated through a bed of the zeolite, and the water leaves the filter bed carrying only a trace of calcium and magnesium salts. Just as an aside, this is the only method of water purification known—aside from distillation itself—which *can* give water that will approximate the theoretical 0.0 deg. hardness.

Some may object to the classification of boiler compounds as a method of purifying water, and with justice. The writer, however, knows of at least one company which, by fitting the compound to the water in a scientific manner, really justifies the terminology of water purification. Since any scientifically prepared boiler compound achieves its object by the precipitation of scale-forming substances inside the boiler, it might properly come under their third classification, but it would strain the limits of this classification, as given by the authors.

The primary object of this letter, however, is to point out some erroneous conclusions and the effects to be anticipated should they be allowed to effect the principles under which the water-softening plant is operated.

Their summarization of results from experiments with soda ash alone reads as follows:

"Sufficient soda ash should be added so that a slight excess of this reagent remains after the chemical action between it and the water has been completed. The excess will have no effect upon the hardness and but little effect on the alkalinity, so that the engineer need have no fear of its presence. This excess will prove of great value in case the raw water varies in initial hardness, as such small fluctuations can be readily cared for by this reagent."

This conclusion is diametrically opposed to the best water-softening practice. The standard practice calls for slightly less soda ash than is sufficient to carry the reactions to completion, and tests on a properly treated water will conform to the following proportions:

The hardness shall be slightly less than the total alkalinity. The caustic alkalinity shall be slightly more than half, but never more than two-thirds of the total alkalinity. Hardness to be determined by titration against a soap solution standardized to read in grains per gallon calcium carbonate equivalent. Total alkalinity to be determined by titration with methyl orange as an indicator. Caustic alkalinity to be determined by titration using phenolphthalein as an indicator. Both caustic and total alkalinity to be reported in grains per gallon calcium carbonate equivalent.

In the laboratory a slight excess over the theoretical amount of soda ash is necessary to carry the precipitation of the calcium salts to completion, but for best results in a boiler this excess is not only unnecessary, but is positively dangerous.

The purpose of softening water for boiler use is the prevention of scale, and under boiler conditions the precipitation is completed with less soda ash than the amount necessary to complete precipitation in the water softener. When this precipitation is completed within the boiler, scale is not formed, but the precipitate settles to the bottom of the boiler as a sludge or mud and is disposed of in the blowoff.

All sulphates, chlorides and nitrates present in the raw water remain in the treated water in the form of the corresponding sodium salt. Of these, the sulphate and nitrate (the latter is very rarely present) show a marked tendency to cause foaming and priming with relatively small concentration. This tendency is greatly increased by the presence of soda ash; with the addition of greater quantities of soda ash, it increases in a double ratio. Hence, while—as pointed out by Messrs. Herrle and Gleeson—the addition of an excess of soda ash will not cause the hardness to rise, as is the case with lime, it does add enormously to the danger of foaming and priming, and a thin film of scale which might be caused by an insufficient amount of soda ash in the treatment would cause far less trouble than would the carrying over of water with the steam, not to mention the fact that it might endanger the lives of the engine room attendants.

Turning now to the question of minimum hardness obtainable. By no precipitation process is the theoretical minimum of 0.0 deg. possible of achievement. The minimum hardness possible with any cold water lime-soda ash treatment is approximately 1.66 g. per gal.

(It is not possible to precipitate down to an amount smaller than the solubility of the precipitate. Calcium carbonate has a solubility of 0.76 g. per gal., magnesium hydrate a solubility of 0.53 g. per gal., or calculated to the calcium carbonate equivalent, a solubility of 0.90 g. per gal., a total of 1.66 g. per gal. calcium carbonate equivalent.)

The soap solution used by the authors of the article under discussion was evidently standardized to some odd factor, for with the presence by analysis of 1.52 g. calcium carbonate, and 0.39 g. magnesium hydrate (0.67 g. calcium carbonate equivalent)—a total of 2.19 g. per gal. of hardness—they report 0.50 deg. of hardness.

The explanation they give, that "the theoretical hardness of 0.0 deg. is not obtainable, being probably due to the small sample of water originally treated," does not argue a wide experience in the water-softening field, nor does it indicate a deep knowledge of the chemistry of water softening. It is well known to water-softening experts that it is possible to secure better results with laboratory-sized samples and with laboratory methods of chemical measurement than can be obtained in industrial water softeners. It is also well known that the "theoretical hardness of 0.0 deg." is impossible of attainment by any method other than distillation, for this would require the total absence of all calcium, magnesium and iron salts. Zeolite softeners sometimes approximate a zero hardness, but they never in fact quite reach it.

The statement, therefore, that "In the water-softening system in operation at our plant it is nothing unusual to obtain a hardness of 0.0 deg." is so palpably impossible that it throws a strong element of doubt upon any conclusion reached in the entire article.

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WILLIAM M. TAYLOR,
Sometime Chemical Engineer,
Kennicott Co., and
Chief Chemist, Refinite Co.

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Chicago, Ill.

Wood Alcohol as a Beverage

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the *Literary Digest* of Feb. 14, I note a review of an article in your publication for Jan. 21, in which is stated that some chemists have asked the Commissioner of Internal Revenue to change the name of wood alcohol to "woodine." I thought it might interest you to know that a short time ago I wrote one of our legislators from this state, the Hon. Carlos P. Bee, suggesting that he endeavor to have a law enacted requiring manufacturers and dealers to label, list and sell wood alcohol as wood naphtha. This will classify the real nature and use, and prevent so many unfortunate mistakes being made by people confusing it with the alcohol of intoxicating liquors.

The whole source of the use of wood alcohol in beverages, medicines, etc., was in the fact that its very name was misleading, and the only way to eradicate the evil and to combat its mistaken use is to inaugurate a campaign of widespread publicity as to its real nature and use, and the most effective means of doing this is to give it a name that classifies its real use. As a pharmacist and chemist I have studied our methods of preventing the uninformed people from misusing wood alcohol and I have come to the conclusion that the only logical course is to have laws passed making it compulsory with dealers and manufacturers to label it "wood naphtha."   O. W. NOLAN.

San Antonio, Tex.

Spring Meeting of the American Electrochemical Society

THE spring meeting of the American Electrochemical Society will be held in Boston April 7 to 10 inclusive. There will be a meeting of the board of directors Wednesday evening, April 7. The following program is announced:

THURSDAY, APRIL 8

The annual business meeting will be held in the morning and the retiring president, Wilder D. Bancroft, will deliver an address on "Contact Catalysis."

Symposium on Colloid Chemistry:

W. D. Bancroft, "Colloid Chemistry and Electrochemistry."

W. A. Deane, "Settling Problems."

T. R. Briggs and W. J. Bartlett, "The Adsorption of Arsenious Oxide by Metastannic Acid and the Purification of Spent Electrolyte."

G. A. Hulett, "Graphitic Acid, a Colloidal Oxide of Carbon."

A. C. Fieldner, "Determination of Graphitic Carbon."

William C. Moore, "Selective Adsorption by Bacillus Pyocyaneus."

Guy Clinton, "A Criticism of Kohlrausch's Law of the Conductivity of Solutions."

H. D. Holler and L. M. Ritchie, "Hydrogen Ion Concentration in Dry Cells."

D. A. MacInnes, "The Reactions of the Lead Accumulator."

William Roy Mott, "Arc Images in Chemical Analysis."

FRIDAY, APRIL 9

Joint meeting with the American Institute of Electrical Engineers, W. D. Bancroft presiding.

Symposium (A.M.) on Electrically Produced Alloys:

H. E. Howe, "Fundamental Problems in Alloys Research."

R. J. Anderson, "Recent Developments in the Ferro-Alloy Industry."

C. B. Gibson, "The Manufacture of Ferro-Alloys in the Electric Furnace."

B. D. Saklatwalla, "Ferrovanadium."

Elwood Haynes, "Stellite."

F. A. Raven, "Properties of Ferrosilicon."

E. S. Bardwell, "Ferromanganese."

R. C. McKenna, "The Manufacture of High-Speed Steel in the Electric Furnace."

Alcan Hirsch, "Ferrocerium."

Theodore Swann, "Ferrozirconium."

B. G. Klugh, "Ferrophosphorus."

R. M. Major, "Nichrome and Other Special Alloys."

T. D. Yensen, "Electric Properties of Nickel-Iron Alloys."

M. A. Hunter, "Electrical Properties of Titanium Alloys."

C. F. Harding, "Nitrogen Fixation by the Silent Discharge."

Symposium (8:30 P.M.) on Power for Electrochemical Industries, President C. Townley of the A.I.E.E. presiding:

John L. Harper, "Power for Electrochemical Plants."

John A. Seede, "Automatic Control of Arc Furnace Electrodes."

H. A. Winne, "Reactors for Electric Furnace Circuits."

C. A. Winder, "Economies of the Power Situation."

E. A. Wilcox, "Electric Furnace Power From the Standpoint of the Central Station."

H. L. Hess, "The Electric Furnace and the Central Station."

C. T. Maynard, "Location of a New England Electrochemical Plant."

F. F. Fowler, "Water Powers of the Pacific Coast."

J. W. Beckman, "Power Development in Scandinavia."

W. G. Berlin, "Power Problems From the Standpoint of the Furnace Operator."

SATURDAY MORNING AT HARVARD UNIVERSITY

J. W. Richards, "The Soderberg Self-Baking Continuous Electrode."

C. A. Jeller, "Synthetic Electric Furnace Pig Iron."

Philip B. Short, "Step Induction Regulators for Electric Furnaces."

Clarence J. West, "The Electric Furnace as Applied to Metallurgy."

H. M. St. John, "The Electric Brass Furnace; Its Evolution."

L. B. Lindemuth, "The Electric Furnace in Iron and Steel Metallurgy."

Edward F. Kern, "Reduction of Manganiferous Silicate Slags."

INDUSTRIAL EXCURSIONS

Trips will be made to the Lynn Works of the General Electric Co., on Friday at 1:30 P.M., and to the Huff Electrostatic Separator Co., on Saturday afternoon.

An informal subscription dinner will be held Friday evening at the Copley-Plaza.

Spring Meeting of American Chemical Society

The following tentative general program has been prepared for the St. Louis meeting of the American Chemical Society, April 12 to 16.

MONDAY, APRIL 12

4 p.m., Council meeting.
7.30 p.m., Council dinner at the University Club.

TUESDAY, APRIL 13

10 a.m., General meeting, Hotel Statler.
Address of welcome, Mayor Henry W. Kiel.
Response, Dr. W. A. Noyes, president, A. C. S

EDWARD MALLINCKRODT, SR.
Honorary Chairman, Executive Committee

Address, the Hon. E. P. Costigan, Tariff Commissioner, "Chemical Industry and Legislation."

Address, Dr. Charles H. Herty, editor, "Victory and Its Responsibilities."

2 p.m., Hotel Statler, general meeting.

J. H. Hildebrand, "The Prediction of Solubility."

Victor Lenher, "Selenium Oxychloride a Neglected Inorganic Solvent."

E. T. Wherry, "Studying Plant Distribution With Hydrogen Ion Indicators."

Three additional general papers to be announced.

8 p.m., Liederkrantz Club. Smoker for men.

8 p.m., Theater party for ladies.

WEDNESDAY, APRIL 14

9 a.m., Hotel Statler, divisional meetings.

2 p.m., Hotel Statler, divisional meetings.

8 p.m., Central High School. Public address. Speaker and subject will appear in final program.

THURSDAY, APRIL 15

9 a.m., Hotel Statler, divisional meetings.

2 p.m., Excursions to Laclede Gas Works, Monsanto Chemical Works, East St. Louis plant, and Laclede-Christy Clay Products plant. Automobile tour for ladies to parks, Art Museum, Washington University, Missouri Botanical Garden, and tea at Bevo Mill.

8 p.m., Hotel Statler, subscription banquet.

FRIDAY, APRIL 16

9 a.m., Excursion to Standard Oil Refinery. Wood River, Ill., and Illinois Glass Co., Alton, Ill.

DIVISIONAL MEETINGS

The usual meetings will be held by all of the divisions except the Fertilizer Division. The Division of Industrial and Engineering Chemistry will hold a symposium on Cellulose Chemistry. The Sections of Leather Chemistry and Sugar Chemistry will meet for the first time. The Division of Physical and Inorganic Chemistry will devote a half day to a "Colloid Symposium." Programs for the divisional meetings are in process of preparation and details will be announced later.

Meeting of Electric Furnace Association

Coincident with the meetings of the American Institute of Electrical Engineers and the American Electrochemical Society, there will be a meeting of the Electric Furnace Association, in Boston, April 8 to 10. The annual election and business meeting will be held on April 8. On one other day there will be a session on the proper training of operators of electric furnaces. The Association will meet with the two other societies mentioned above during their discussions on Electrically Produced Alloys and Power for Electrochemical Purposes. The combined program will be of particular interest to electric-furnace operators, inasmuch as subjects of such vital importance to the industry will be discussed. Indications are that there will be a good attendance of electric-furnace men at these sessions and that very excellent papers will be presented. During the meeting the headquarters of the Electric Furnace Association will be at the Copley-Plaza Hotel.

The Dye Industry of Great Britain

During the last year there has been considerable criticism by users of the range of dyes available either from British dye-manufacturing works or from the supplies which have been imported from Germany in fulfillment of the terms of the treaty of peace. These criticisms appear to arise from a fear that the British textile trade may be placed at a disadvantage in the markets of the world.

It is claimed that 80 per cent of the dyes now being used in Great Britain are of home production, but the total quantity available, even of the common grades, does not appear to be sufficient for the needs of the textile manufacturers, to say nothing of the high-class dyes. Prior to the war the highly organized German dye combine maintained in Great Britain large stocks of dyes from which immediate deliveries could be made. At the present time the British dye industry is making strenuous efforts to meet the demand, but is not able to keep a stock on hand for immediate delivery, as the dyes are sold even in advance of production and shipped direct from the plant.

For several months past there has been a great deal of anxiety on the part of dye manufacturers as to the future of the British dye industry, owing to the fact that certain high-class dyes which are very much needed in the textile and other trades are not produced in Great Britain. The fear of the possibility of the removal of the restrictions on the importation of German dye-stuffs, or the necessity of the government taking some action to secure for the trade these high-class dyes, seems well founded, from the fact that it is now announced that a committee, representing all the industries using dyestuffs, is now in Germany for the purpose of purchasing such dyes as are required by the British consumers and is authorized to buy up to £2,000,000 worth of fine dyes.

The British Government is reported as taking no part in the financial arrangements, but has granted the necessary facilities for this committee to make these purchases. Any dyes that the committee may secure will be in addition to the 1,500 tons to which the British users are entitled under the reparation clause of the Peace Treaty.

Government Kelp Plant to Continue Operations

The House of Representatives has approved an appropriation of $192,000 "for the completion, operation, and maintenance of the Government kelp plant at Summerland, Cal." The following conclusions of the Department of Agriculture specialists have apparantly had much to do in influencing the House to grant the appropriation in face of persistent efforts to eliminate or reduce the appropriation:

(1) Results to date show definitely that the successful outcome of experiments is assured that byproducts will be developed which will more than carry the production cost of potash. This will enable kelp potash, then, to come into the market where freight rates are not prohibitive, in competition with potash from any other source.

(2) With a successful outcome assured, it would be unwise to discontinue the work and lose the credit which is bound to accrue to the Government through the successful prosecution of a problem undertaken in the face of so much criticism and one advertised so widely by its opponents as illogical and uneconomical.

(3) Its continuation from now on will be at a very slight and decreasing expense to the public, the proceeds from this year's production probably being about

enough to equal expenditures and those from next year's operation probably more than equaling expenditures. That the enterprise will be self-sustaining within a short period seems assured.

(4) It should be borne in mind that at the completion of the work, with the results anticipated, the plant will be on a profitable basis and could be put on the market as a going concern earning a profit, and would yield a price accordingly. If it is sold before all the facts are demonstrated it would have to be sold as junk, and as such would yield only about a third of what it would yield otherwise. If sold as a going concern, however, it would yield not less than $100,000.

It is easy to see, therefore, that if we keep going until the work is completed, the net profit to the Government will be greater than if the work were discontinued at the end of the present year.

(5) Since it has been demonstrated that not less than 500,000 tons per annum of raw kelp are available in the vicinity of Summerland, it is to be assumed that when it is demonstrated what profits are obtainable from the treatment of kelp by the process developed here plants will be established sufficient in capacity to utilize the raw material available. We may with confidence, therefore, look forward to the establishment ultimately of an industry in this part of the State of California which will yield the products obtainable from this quantity of kelp and of an annual value of over $7,000,000. This estimate does not take into consideration the equally large industry which may be founded additionally on the kelps of Puget Sound and Alaska. The profit to the public, therefore, from the successful outcome of these experiments seems to be beyond question, and certainly would seem to justify a continuation of the slight net expense to the public now being incurred in this work.

Bureau of Chemistry Appropriation

As reported to the Senate, the agricultural appropriation bill carries $1,393,591 for the Bureau of Chemistry. This is $72,000 more than the total of the appropriations allowed in the bill passed by the House.

The bulk of the increase was allowed on items providing funds for conducting the investigations relating to the application of chemistry to agriculture; for the work connected with the food and drug act and for the investigation of chemical problems relating to insecticides and fungicides. An increase also was allowed to the Bureau of Soils for that portion of its work having to do with chemical properties of soils. The appropriation for that purpose as recommended by the Senate committee is $25,610.

A fund of $36,840 is provided for exploration and investigation within the United States to determine possible sources of potash, nitrates and other natural fertilizers.

Forest Products Laboratory Appropriation

In the agricultural appropriation bill which has been reported out by the Senate committee, the appropriation to be used at the Madison (Wis.) Laboratory of the Forest Service is increased from $173,260, allowed by the House, to $223,260. This money is to be expended for investigations of methods for wood distillation and for the preservative treatment of timber; for timber testing and for testing of such woods as may require test to ascertain if they be suitable for making paper; for investigations and tests of foreign woods of commercial importance to industries in the United States and for other investigations and experiments; to promote economy in the use of forest products and for commercial demonstration of improved methods or processes in co-operation with individuals and companies.

Meeting of American Section, S. C. I.

On Friday, March 19, there was an unusually large attendance at the monthly meeting of the American Section of the Society of Chemical Industry at the Chemists' Club. Chairman Charles E. Sholes submitted the following nominations for officers, which were approved and ordered forwarded to London for final approval: Sumner R. Church, chairman; F. C. R. Hemingway, treasurer; Allen Rogers, secretary; committee: Charles E. Sholes, Ralph H. McKee, Wallace P. Cohoe, D. D. Jackson, H. G. Carrell.

The opening paper by Bruce Silver consisted mainly of slides gathered by the author in a recent tour through the American petroleum fields. Moving picture reels furnished by the Standard Oil Co. were used in conclusion, giving the audience an excellent mental picture of the industry.

Speaking on the subject of "The Manufacture of Rare Chemicals," Dr. C. E. Kenneth Mees reviewed the progress in this country in the manufacture of organic reagents required for industrial and university research laboratories. Chemicals of this class were imported almost exclusively before the war and the shutting off of imports, coupled with the sudden development of the synthetic organic industries, created a situation which rapidly became acute. To meet the increasing demand, Dr. Derrick and later Dr. Roger Adams at the University of Illinois set some of the graduate students in organic chemistry to work on the problem during the summer vacation. The venture was so successful and the development so rapid that it soon became necessary for an industrial firm to take over the production of these small-scale products and also to engage in the purification for research work of certain of the technical organic chemicals which were beginning to appear on the market. This phase of the work was taken up by the Eastman Kodak Co., which now acts as distributing agent for these research chemicals. This requires the keeping of small stocks of a large number of chemicals, which means a large financial investment in proportion to the turnover. Thus, a $50,000 stock would be required for a turnover of about $20,000 a year. Over six hundred chemicals are now available and the list is being rapidly extended.

Much of the work is being done in an improvised laboratory which, judging from the view shown, has reached its productive limit. A larger laboratory will be established in the near future.

Senate Hearings on Fixed Nitrogen Corporation Bill

Senate hearings on the bill to establish the United States Fixed Nitrogen Corporation for the purpose of purchasing and operating the nitrate plants at Muscle Shoals were scheduled to begin before the Committee on Agriculture on March 22. The bill proposes the organization of a corporation, all the capital stock of which shall be owned by the Government. Evidence probably will be introduced to show that the plants should be operated and that such operation should be conducted by the Government through a special corporation rather than by private interests. Among those who may appear before the committee are Secretary Baker, George J. Roberts, Alfred H. White, Arthur B. Lamb, Colonel Burns, Colonel Joyes and Major Gaillard.

Investigation of Fuel-Oil Fire Hazards

Owing to widely divergent views as to the fairness of the tentative fuel oil regulations recently issued by the National Fire Protection Association, E. A. Barrier, chairman of the committee on inflammable liquids of that association, has deemed it advisable to institute immediately a thorough investigation throughout the fuel oil-consuming centers of the country and to gather first-hand information relative to the existing conditions prevalent with regard to fire protection and fire hazards.

Mr. Barrier has asked for the co-operation of the American Petroleum Institute in connection with this important subject. Therefore, it has been decided to engage the services of C. F. Reuter, who was formerly associated with the Tidewater Oil Co's engineering department, to represent the American Petroleum Institute and to accompany F. O. Aspinwall, who was appointed by the National Fire Protection Association to represent the interests of the insurance companies in this investigation.

Considerable significance is attached to the results of this investigation, which will probably cover a period of six weeks. Upon ascertaining the true condition as to fire hazards in the storage and use of fuel oil, it is hoped that the present regulations will be modified so as to possess nothing of a discriminatory character, yet at the same time to conform to established good practice in providing proper safeguards against the danger of fire and accident.

A Grant for Research

The American Pharmaceutical Association has available a sum amounting to about $450 which will be expended after Oct. 1, 1920, for the encouragement of research. This amount, either in full or fractions, will be awarded in such manner as will in the judgment of the association's research committee produce the greatest good to American pharmaceutical research. Investigators desiring financial aid in their work will communicate before May 1 with H. V. Arny, chairman A. Ph. A. research committee, 115 West 68th St., New York, giving their past record and outlining the particular line of work for which the grant is desired. The committee will give each application its careful attention and will make recommendations to the association at its meeting in Washington, May 3 to 8, 1920, when the award or awards will be made.

Revised Text of Federal Reserve Act Issued

A book containing the Federal Reserve act, revised to include all amendments to Dec. 24, 1919, has been issued by the National Bank of Commerce in New York. The volume is prepared for reference purposes, being fully indexed and provided with marginal annotations. Several of the amendments are particularly significant in connection with recent international developments affecting American banking, such as the Edge act and sections relating to the investment by national banks in foreign banking and financing corporations organized under Federal or state laws.

Platinum at Goodsprings, Nevada

The Boss mine at Goodsprings, Nev., which so far as known is the only lode mine on the continent in which platinum is found, shipped $22,365 worth of platinum-bearing ore during 1919.

Electrolytic Zinc Plant of the Judge Mining & Smelting Co.

A Description of the Treatment of Table and Jig Concentrates at Park City, Utah—Leaching—Purification of the Solution—Electrolytic Plant Installation and Operation—Power Consumed—Daily Production Capacity

By L. W. CHAPMAN

THE electrolytic zinc plant of the Judge Mining & Smelting Co., at Park City, Utah, is designed to treat concentrates obtained from a sulphide ore containing zinc, lead and silver. In their concentrator a lead concentrate and a zinc concentrate are obtained. The lead concentrate is shipped and smelted. The zinc concentrate is treated in the plant for the recovery of zinc and the zinc-plant residue is shipped and smelted for the recovery of the silver and lead. This briefly is an outline of the treatment of the ore. The removal in the mill of a large portion of the zinc from the ores produces a concentrate which can be economically smelted for the recovery of the lead and the silver. Previous to the construction of the electrolytic zinc plant a zinc concentrate had been obtained, which was sold to smelters.

TREATMENT OF THE CONCENTRATE

The concentrate treated in the zinc plant contains about 38 per cent Zn, 3 to 5 per cent Pb, and 9 to 10 oz. Ag per ton, with small amounts of copper, cadmium, antimony, manganese and arsenic. Concentrates will average about 30 per cent sulphur and 8 per cent iron. Two grades of concentrates are delivered to the zinc plant—a table product and a jig product. These are kept separate, as the jig concentrate is too coarse to give satisfactory recovery of zinc without grinding. The jig product is dried in a cylindrical drier and ground in a Hardinge ball-mill to pass 60 mesh, this size being obtained without screening the product with the return of oversize to the mill. The table concentrate is somewhat coarser than the Hardinge mill product, about 20 per cent being retained on a 60-mesh screen.

Concentrates are roasted in a 25-ft. seven-hearth Wedge roaster which is fired on the sixth hearth by two coal-fired combustion chambers located at opposite ends of a diameter of the roaster. The seventh hearth is used to cool the calcine somewhat before being delivered to a Baker cooler. The roasting operation produces a calcine containing a relatively small amount of insoluble zinc ferrate, most of the insoluble zinc being present as sulphide. Details of the roasting operation, together with data obtained from experiments with this roaster have been published by C. A. Hansen.[1]

METHOD OF FEEDING

The product from the Hardinge mill is elevated by a bucket elevator and fed directly onto the top or drying hearth of the Wedge roaster by means of a belt conveyor. The table concentrates are also elevated by a bucket elevator, but are transferred to a feed hopper by a belt conveyor. Below the discharge spout of the feed hopper, at a distance of approximately 6 in., is a horizontal iron plate which prevents the flow of material from the hopper. Adjustable scrapers are bolted to each of

the four rake arms of the drying hearth, and these scrape a definite amount of concentrates from the plate onto the hearth. This method of feeding is simple in detail and, although the amount of feed varies somewhat with the moisture content of the concentrate for a given set of scrapers, has operated satisfactorily.

LEACHING OPERATION

Hot calcine flows by gravity from the roaster to a 5 x 12-ft. Baker cooler and from the cooler is transferred by a belt conveyor to a 400-ton storage bin. From this storage bin the calcine is elevated by a hoist to feed bins located above Pachuca tanks. There are two of these tanks, 14 ft. in diameter and 30 ft. in height, made of 3-in. redwood, each holding about 100 tons of solution. In conducting the leaching operation, the Pachucas are filled by gravity with acid electrolyte from storage tanks, together with sufficient sulphuric acid to make up for the loss sustained in neutralization and subsequent operations. The quantity of acid in the tank is determined from the analysis of the solution and an amount of calcine added which is calculated to reduce the acidity of the solution to about 3 g. H_2SO_4 per liter. In addition to zinc, small amounts of copper, cadmium and antimony are dissolved, and these must be removed before the solution is electrolized. As the first step in the purification process iron sulphate is added in the Pachucas sufficient to bring the iron contents to about 0.3 g. per liter. Pulverized lime rock is then added, with further agitation, and the remaining acid completely neutralized. This effects a complete precipitation of the iron and a practically complete precipitation of the antimony and arsenic. The leaching cycle requires from 8 to 10 hr.

SEPARATION OF THE SAND AND SLIME

A centrifugal sand pump delivers the neutral pulp from the Pachucas to a No. 7 drag classifier. The sand from the classifier is delivered to a storage bin, the overflow to a 30-ft. Dorr thickener. The overflow of the Dorr is clear solution and is pumped to the purifying Pachucas, the spigot product from the Dorr is filtered and washed on an 11½ x 6-ft. Oliver filter. Oliver cake is delivered to a storage bin and the filtrate pumped to the purifying Pachuca containing the overflow from the Dorr.

The sand from the classifier and the filter cake contain the silver and lead from the concentrate together with the insoluble zinc and the soluble zinc which has not been removed by washing. This residue is shipped to smelters for the recovery of the silver and lead, as previously mentioned. The sand and slimes together are about half the bulk of the original concentrates. The slimes will carry 10 to 12 per cent zinc and the sand 15 to 20 per cent zinc, and together will assay about 12 per cent lead and 20 oz. silver per ton. It is not possible to

[1] "Electrolytic Zinc," by C. A. Hansen, *Trans.*, A. I. M. E., 1919, pp. 1,247-1,281.

wash the Oliver cake or the sands free from zinc sulphate, and a loss of both zinc and sulphuric acid results. This makes it necessary to add about 70 lb. of 50 deg. acid to the Pachucas for each ton of zinc produced.

PURIFICATION OF THE SOLUTION

Purification of the solution is carried out in Pachucas by agitation with zinc dust. There are three of these tanks, 10 ft. in diameter x 20 ft. in height, made of 2-in. redwood, each having a capacity of about fifteen tons of solution. The Pachucas are filled with solution and the zinc dust is added in small batches. The quantity of zinc dust needed, the rate of addition and the time required for this operation are determined by the amount of impurities present in solution, but the operation is usually complete in from 20 to 30 min. In this operation all but minute traces of copper and cadmium and also any traces of antimony and arsenic that may have escaped precipitation simultaneously with the iron in the agitation tanks are removed.

Purified solution is filtered in either one of two Sweetland presses and the zinc-copper-cadmium sludge removed. These presses have 36 leaves, each $3\frac{1}{2}$ ft. in diameter. Sweetland filter cake is stored, but a method for the recovery of the metals from the cake which contains 40 to 50 per cent Zn, 4 to 7 per cent Cu and 3 to 6 per cent Cd has recently been developed. The filtrate from the Sweetland presses is pumped to either of two 200-ton solution-storage tanks, from which it is run directly to the electrolytic cells as required. The average analysis of the purified solution is as follows, in grams per liter: Zn, 60; Cd, 0.004; Cu, 0.003; Mn, 0.4; Sb, 0.001; As, trace.

ELECTROLYTIC CELL ROOM

The electrolytic cell room contains 120 tanks. The tanks are arranged in cascade. Five tanks, which constitute a cascade, are placed end to end, the difference in elevation between tanks being 3 in. Two cascades of tanks are placed side by side, forming a bank of ten tanks. There are six of these banks across the cell room with aisles between and between the outside banks and the walls of the cell room. There are two of these sections of sixty tanks down the cell room with a wide aisle between the two sections and below the lower section providing ample room for stripping of cathodes.

Solution from the storage tanks is run into the head tank of each cascade, the flow being parallel throughout a section, each of which is provided with separate solution supply lines. Each section of sixty tanks also forms one electric circuit, the individual tanks of the section being connected in series.

DESIGN OF THE TANKS

The tanks are of standard design and are made from 2-in. redwood, and are 7 ft. long, 3 ft. wide and $4\frac{1}{2}$ ft. deep. The overflow chute is made of chemical sheet-lead and is supported on a wooden bracket. The solution level in the tank is 2 in. below the top of the side walls. The chute clears the top of the next tank in the cascade by 1 in. and delivers the solution about 2 in. beyond the inner edge of this tank. Each tank is provided with a cooling coil installed in an upright position at the inlet end. The coil is made from 45 ft. of 1-in. chemical lead pipe, there being five 4-ft. loops to a coil. The solution is delivered to the head tank of the cascade from the storage tanks through iron pipes and the amount of flow controlled by gate valves. Provision is also made to run fresh solution to each tank if desired. The acid electrolyte from the lowest tank in the cascade flows into a lead pipe and thence by gravity to either of two 200-ton storage tanks located outside the building. From these tanks the solution is pumped by a centrifugal pump, with a closed bronze runner, to the supply tanks located above the agitating Pachucas and runs from these supply tanks to the Pachucas by gravity, thus completing the cycle.
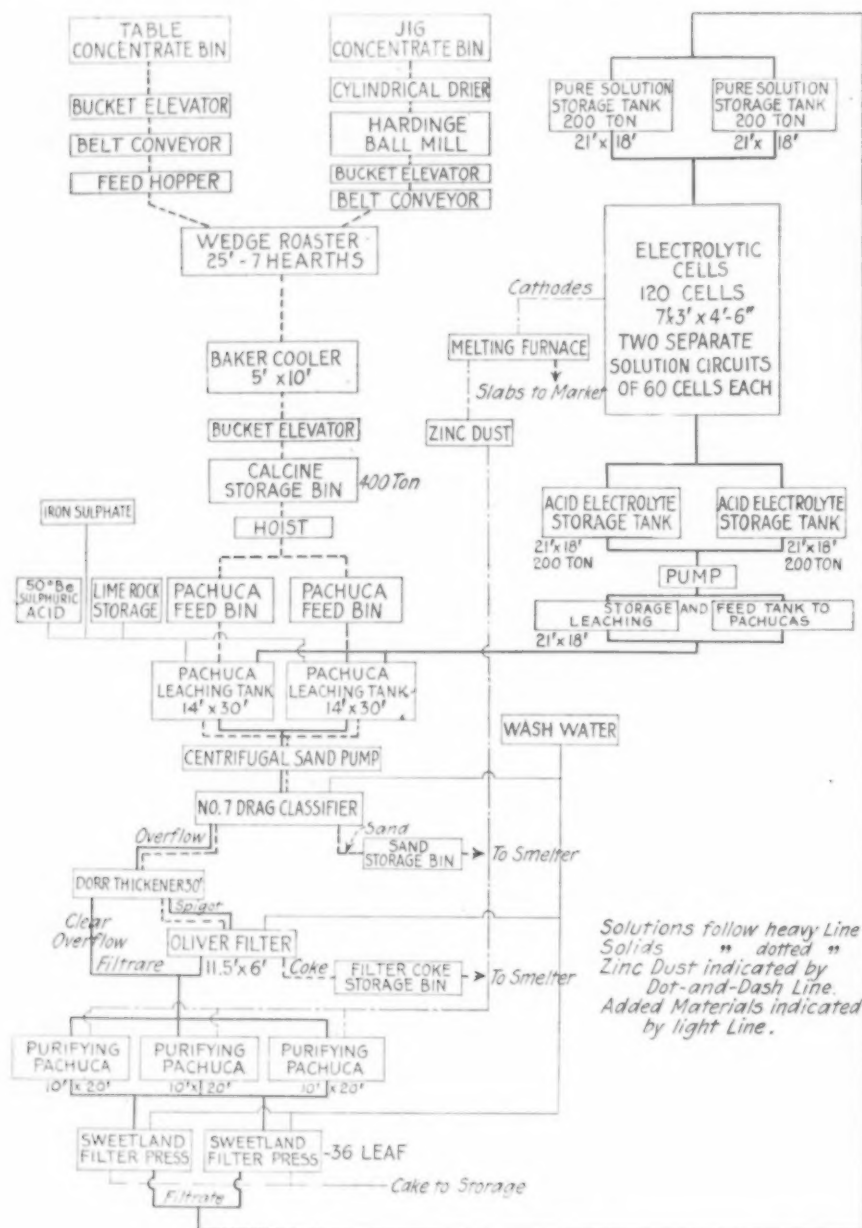
FLOW-SHEET, JUDGE ELECTROLYTIC ZINC PLANT

Anode and cathode busbars are both put on the side of the tank next to the aisle and are supported free from the tank by three 6 x 6-in. wooden posts carried down to separate concrete piers. Advantage is taken of the fact that the amount of current carried by the busbars decreases with each anode contact and increases with each cathode contact to effect a considerable saving of copper; the busbars are therefore tapered from ½ in. at the free end to 4 in. at the other, where connections are
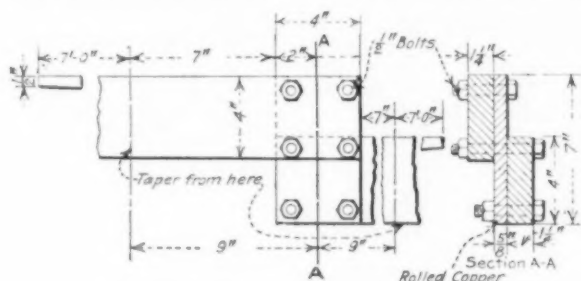
DETAILS OF BUSBAR CONNECTION

made to the bus of the next tank. The maximum cross-section of the busbars is 1¼ in. x 4 in. They are made from rolled copper and supported with the long dimension of the cross-section vertical, the anode bus being on the inside next to the tank and ¾ in. lower than the cathode bus. The busbars are insulated from each other and from the guides of the wooden support by means of glass insulators ½ in. in thickness. The weight of the bus is carried upon glass blocks 1¼ in. in thickness.

The connection between busbars is made by means of a plate of rolled copper ⅜ x 4 in. in cross-section. This plate is bolted to the inside of the cathode bus and to the

DETAILS OF BUSBAR SUPPORT

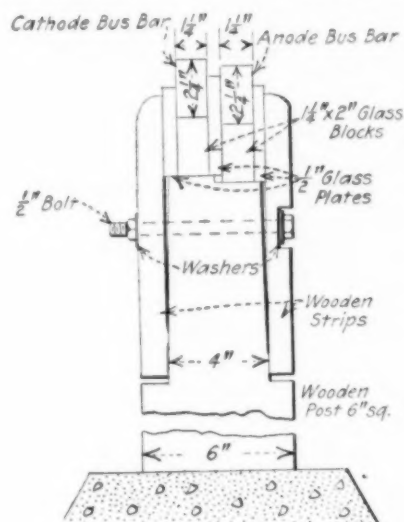outside of the anode bus. The difference in elevation of the tanks of 3 in. makes it possible to have the top bolt holes of the lower or anode bus register with the bottom bolt holes of the top or cathode bus, the two bars and the connecting strip being bolted together with two ½ in. bolts. Two bolts secure the connecting strip to the cathode bus at the top of this strip and two bolts secure the connecting strip to the anode bus at the bottom.

THE ANODES

Anodes are made of chemical sheet lead ¼ in. thick, the area immersed being 21 in. wide x 33 in. deep. The anodes hang vertically in the tank, and are supported by

1-in. square rolled steel rods and weigh about 100 lb., complete. The supporting rod is 41 in. long and extends 9 in. beyond the edge of the anode on one side, being supported by a wood strip resting on the top of the inner wall of the tank and 11 in. on the other in order to clear the top of the outer wall of the tank and rest on the anode bus. The anode was originally supported by being cast around the rod. Electrical contact was provided by sweating the lead to the rod. This method has not proved satisfactory in operation due to the fact that zinc sulphate will creep in between the lead and the rod, causing a poor contact. This resulted in a very decided increase in electrical resistance which caused heating
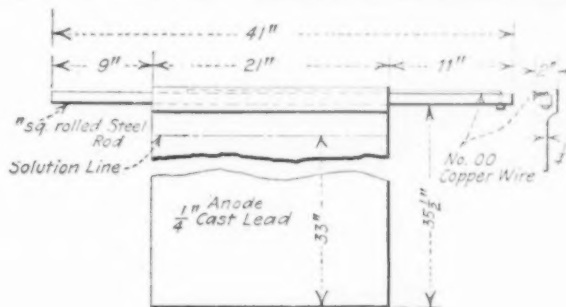
ANODE DETAILS

and further disintegration. The defect has been overcome by burning into the lead above the steel rod a length of tinned No. 00 copper wire. A hole is drilled through the iron bar where contact is made with the anode bus and the copper wire passed through this hole and riveted on the under side. This provides a copper circuit from the anode bus to the lead plate.

THE CATHODES

Cathodes are made of best rolled sheet aluminum, ⅛ in. in thickness. The immersed area is 22 in. wide x 34 in. deep. The cathode rod is made from two strips of rolled copper, ⅛ in. thick x 1½ in. wide x 44 in. long. These are riveted together with the aluminum sheet between. The rod extends 9 in. beyond the aluminum sheet on one side, being supported on the same wood strip on which the anode rod rests, and 13 in. on the other so as to clear
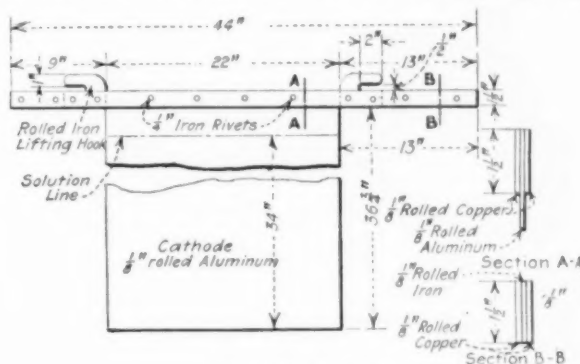
CATHODE DETAILS

the top of the outer wall of the tank and the anode bus and rest on the cathode bus. An iron lug is riveted between the copper strips at each edge of the aluminum sheet, forming a hook by which the cathodes are removed from the tank for stripping. The remaining space between the copper strips at each end is filled with an iron strip and the three strips are riveted together.

In each tank are nineteen anodes and eighteen cathodes which are spaced 2 in. center to center. The im-

mersed cathode area is 203.5 sq.ft. and the effective immersed anode area is 173.25 sq.ft. per tank. With a current of 5,000 amp. the density per sq.ft. of cathode area is therefore 24.5 amp. This current density was chosen as the most economical under operating conditions. The higher the current density the greater the cathode production per kw.-hr., since the resistance of the solution is practically constant for all densities. Too high a current density will, however, produce a poor cathode deposit with a resulting decrease in the current efficiency due to re-solution of the deposited zinc by the acid in the electrolyte. The amount of zinc re-dissolved is increased by rough and non-coherent deposits. The rate of flow of solution through the tanks is such that the acidity of the electrolyte leaving the last tank in the cascade is about 60 g. per liter. This acidity was also chosen as the most economical under operating conditions. The higher the acidity of the solution the greater the amount of deposited zinc dissolved, with the result that there is a decrease in the current efficiency. There are other factors, of course, to be taken into consideration in determining the most economical current density to use in relation to the amount of free acid and zinc sulphate in the effluent solution; such as the cost of cooling the solutions, the cost of power, the market price of zinc, the problem being complicated because these factors are interdependent. The voltage drop per cell will vary from about 3.7 volts in the head cell to 3.3 volts in the last cell in the cascade, the average being about 3.5 volts.

The effect of the electrolysis upon the solution is shown in Table I. It is to be noted that about 20 g. per liter of Zn remains in solution, this amount being carried through the cycle.

TABLE I. EFFECT OF ELECTROLYSIS

	Zn	H_2SO_4	Cd	Cu	Sb	Mn
			Grams per Liter			
Feed to head cell	59.5	0.2	0.003	0.0006	0.0010	0.415
Overflow from tail cell	21.7	58.1	Trace	0.0003	0.0007	0.035

Manganese is deposited at the anodes as dioxide. The deposit is, however, non-coherent and all but a thin film which adheres to the anode settles to the bottom of the tanks. The tanks are cleaned of this mud about once a month; at present no use is made of this product. The solution flows directly through the tanks. It is not necessary to admit the solution near the bottom at one end of the tank with the overflow from the top at the other, or vice versa, since evolution of gas from the anode suffices to prevent stratification of the solution.

The cathodes are removed from the tanks and stripped of the deposited zinc every 48 hr., the average weight deposited per tank being about 515 lb. The smooth crystalline deposit on the cathode sheets is about ¼ in. in thickness. The cathodes are lifted from the tanks by means of a lifting frame attached to a 1-ton chain fall which runs on an overhead trolley. The lifting frame has two side-pieces made from 1½-in. angle iron and cross-braced, the toes of the angle-iron being horizontal and directed inward. V-shaped notches are cut in the toe, spaced 4 in. center to center; when the frame is lowered these notches permit the toe of the angle-iron to be slipped endwise under the lugs on the cathodes. The lifting frame removes six cathodes at one time. The cathodes are conveyed by the trolley to the aisle at the end of the section and deposited in a portable stripping frame, where the wooden side strips are removed and

the deposited zinc is stripped from the aluminum sheet. The cathodes are thoroughly cleaned, dry wooden side-strips are put on each edge and are then replaced in the tank. These side-strips are made from a ¾-in. square strip of wood, 36 in. long, with an ⅛-in. slot ¼-in. deep cut along one side. The wooden strips extend the full length of the cathode sheet and slip tightly over the aluminum sheet and are thus held in place. Side-strips are necessary for the convenient removal of the deposit, and also prevent the formation of irregular deposits at the edge of the sheets.

Cathodes are then melted in a coal-fired reverberatory melting furnace and cast into standard sized slabs for the market. The average analysis of the refined zinc is Zn, 99.930; Fe, 0.005; Pb, 0.038, and Cd, 0.027 per cent.

POWER

The power for operating the plant is purchased from the Utah Light & Power Co. and is delivered to an outdoor transformer station at 40,000 volts, there being three independent sources of supply. The voltage is transformed to 2,300 volts for the synchronous motors and to 440 volts for miscellaneous power uses about the plant, such as operating the air compressors which supply air to the Pachucas, operating the sand and solution pumps and calcine elevators.

Direct current is generated for the tank room by two motor generator sets driven by synchronous motors, the generators being rated at 5,000 amp. at 215 volts. The switchboard installation is arranged so that either generator can be used to supply current to either section of sixty tanks. Provision is made for forced ventilation of the motor generator room by washed air.

PRODUCTION

The plant was one of the first electrolytic zinc plants to be put into operation and was designed to produce fifteen tons of zinc per day, but under operating conditions that have developed the plant will require enlargement in some departments to attain this tonnage. The Wedge roaster will supply sufficient calcine for not more than nine tons of zinc and additional agitating Pachucas will also be needed in order to obtain the rated capacity. It is interesting to note that the original cells in this plant were designed to use the rotating cathodes that were developed at Bully Hill, but that with the development of the process, particularly in the purification of the solution for electrolysis, it was found to be advantageous to install new tanks and to use stationary cathodes.

ACKNOWLEDGMENTS

Thanks are due to G. W. Lambourne, of the Judge Mining & Smelting Co., for permission to publish these notes, and to John T. Ellsmith for courteously assisting in the collection of the material at Park City.

Marking of Imported Goods

A Federal proclamation has been issued in Australia prohibiting the importation, except with the consent of the Minister of Trade and Customs, of all articles to which or to the coverings of which there is applied any marking in a language other than the language ordinarily used by the people of the country of origin, unless there is also applied to such articles or to their coverings a definite qualifying statement in the English language indicating the country in which the articles were made or produced.

The History of Mustard Gas

By Clarence J. West

THE discovery and commercial perfection of the reaction between ethylene and sulphur chloride is being aired in the controversy (*J. Soc. Chem. Ind.*, vol. 38, pp. 344R, 363R, 432R, 451R, 469R) which has grown out of an attempt on the part of Dr. H. Levinstein (*J. Soc. Chem. Ind.*, vol. 38, p. 248T) to defend the German Chemical Service against the criticism of Sir William Pope (*J. Chem. Soc.*, vol. 115, p. 397; 1919) that the service was inefficient because of the method employed for the early manufacture of mustard gas. There is no attempt to question the loyalty of Dr. Levinstein or of the men associated with him, for their services in the great war place that beyond doubt. The questions at issue appear to be to whom credit should be given for the discovery of the reaction and how much credit is due to each party for its commercial development. There also seems to be a fear on the part of our British allies that America claims the reaction as her own, from a statement in Dorsey's article (*J. Ind. Eng. Chem.*, vol. 11, p. 281; 1919). It has been clearly recognized all through the war that we were indebted to the British for the information, not only regarding this but many other processes and developments. If full credit has not been given it is not because of any desire on our part to claim things not our own. A further question, which must be settled in the laboratory, involves the chemistry of mustard gas, and in particular its reaction with sulphur chloride.

Chlorhydrin Process

The early method of preparation of mustard gas, used both by the Allies and by the Germans, was based upon the reaction as published by Victor Meyer in 1886 (*Ber.*, vol. 19, p. 3,260) and further studied by Clarke (*J. Chem. Soc.*, vol. 101, p. 1,583; 1912). This consisted in the formation of dihydroxyethyl sulphide by the interaction of sodium sulphide and ethylene chlorhydrin:

$$2ClCH_2CH_2OH + Na_2S = (HOCH_2CH_2)_2S + 2NaCl,$$

and the subsequent reaction with HCl or thionyl chloride:

$$(HOCH_2CH_2)_2S + 2HCl = (ClCH_2CH_2)_2S + 2H_2O.$$

This method was adopted because analyses of German duds showed fairly conclusively that Germany was manufacturing its mustard gas in this way. English and American chemists, therefore, spent several months in improving and adapting Meyer's method to commercial operation. (See, for example, Gomberg, *J. Am. Chem. Soc.*, vol. 41, p. 1,414; 1919.) First of all, a method had to be developed for the large-scale production of ethylene. This was successfully solved by the British through the use of alcohol vapor and heated phosphoric acid (Newth, *J. Chem. Soc.*, vol. 79, p. 915; 1901; Pope, *J. Soc. Chem. Ind.*, vol. 38, p. 345R; 1919). The Americans found that passing a mixture of alcohol and water vapors over kaolin heated to 500-600 deg. C. gave a satisfactory yield of a very pure product (Dorsey, (*J. Ind. Eng. Chem.*, vol. 11, p. 288; 1919). The second step, the production of ethylene chlorhydrin by the reaction of ethylene, chlorine and water, was less successful. Confidential information from British sources show that Irvine developed a catalyzer for the reaction that was fairly satisfactory. Gomberg was able to work out a satisfactory laboratory method and condition for purifi-

cation which offered commercial possibilities, but at that time the need no longer existed. The other steps offered little difficulty, but everyone is convinced that, as Dorsey states, "the process used by Meyer, namely, the chlorhydrin procedure, proved to be unsatisfactory for huge-scale production." Fortunately, through the efforts of Pope and Levinstein, the method was not needed.

Ethylene-Sulphur Chloride Reaction

The early history of the reaction between the sulphur chlorides and ethylene (the reaction which is the subject of the controversy) is very unsatisfactory. It appears that Despretz (*Ann. chem. phys.*, vol. 22, p. 428) observed the formation of a disagreeably smelling fluid by the reaction of ethylene upon sulphur chloride. Niemann (*Ann.*, vol. 113, p. 288; 1860) obtained a product which he believed to be the disulphide, $(C_2H_4)_2S_2Cl_2$, by the action of ethylene upon a mixture of the two sulphur chlorides ("brown" sulphur chloride), of which he says:

"The characteristic property of this oil is also a very dangerous one. It consists in the fact that the minutest trace which may accidentally come in contact with any portion of the skin, though at first causing no pain, produces in the course of a few hours a reddening and on the following day a severe blister which suppurates for a long time and is very difficult to heal."

The same year Guthrie (*Quart. J. Chem. Soc.*, vol. 12, p. 117; 1860) studied the reaction of ethylene upon sulphur dichloride, and the following year the reaction with sulphur monochloride. Since he allowed the ethylene to remain in contact with the chloride for 20 hr. at 100 deg., it is very unlikely that he had any mustard gas. This is supported by the fact that the product was non-toxic and produced only a slight soreness when placed beneath the tongue. From the experiments carried out by the Chemical Welfare Service, it is very doubtful whether Green is correct in his statement that "mustard gas can be produced of satisfactory purity and in good yield by reacting ethylene with sulphur monochloride at a temperature which is never below 100 deg. throughout the whole reaction." This is the experience of Pope, who reports that at a temperature above 65 deg. practically no mustard gas is formed. On the other hand, Green is undoubtedly right in his contention that pure mustard gas is not materially attacked by sulphur chloride. These facts are probably explained by the formation of an intermediate compound of ethylene and sulphur chloride as observed by Conant (See *J. Am. Chem. Soc.*, vol. 42, p. 585; 1920).

This reaction was next studied by Spring (*Bull.*, vol. 48, p. 629), who ascribed to the product the formula

$$ClCH_2CH_2S\text{-}SCH_2CH_2Cl.$$
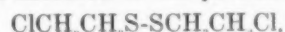
Failure of the Sulphur Dichloride Process

The possibility of preparing mustard gas by the reaction of ethylene and sulphur dichloride was suggested in America in 1917. Several laboratories (unpublished reports, Bureau of Mines) tried the reaction, but obtained a compound containing three chlorine atoms. This is perfectly clear in view of the studies of the behavior of pure mustard gas or its solutions with sulphur dichloride; a chlorinated mustard gas results, which has about the same boiling point as pure mustard gas, but which is practically lacking in vesicant properties. The reaction was therefore dropped for the time and all energies were concentrated on the chlorhydrin method.

In January, 1918, a cablegram was received by the

American Gas Service to the effect that Pope had succeeded in preparing mustard gas from ethylene and sulphur dichloride. In spite of very careful trials the method could not be duplicated by the American University. It was natural that attention should be turned to the monochloride, and the day previous to the receipt of a cable from England to the effect that Pope had successfully carried out the reaction, the experiment was started by Conant. There is thus no question as to Pope's claim to the reaction. Green has made much of the fact that the reaction is not entirely novel, as Pope claims, and in this he is probably justified. The reaction is recorded in the literature and in Beilstein. Credit is due him, however, not only for calling attention to this reaction but in showing that, on a laboratory scale, the reaction was very simple and gave a mustard gas in good yield and of sufficient purity so that it appeared perfectly feasible to proceed with a commercial development. All the world now realizes how much this meant to gas warfare.

LABORATORY METHOD MODIFIED IN FACTORY

Every one who has attempted to place a laboratory reaction into commercial production will sympathize with the attitude that Green takes (*J. Soc. Chem. Ind.*, vol. 38, p. 363R) regarding the amount of research necessary. It should be a well-recognized fact that no laboratory method is directly applicable to factory conditions, and further, that in a large number of cases the conditions of operation may entirely change as the result of experience gained in the factory. It is not surprising, therefore, that Levinstein, Ltd., having the fundamental idea as developed by Pope, should be able so to modify the reaction conditions that a superior working method and product should result. Had Pope followed the method into factory production, which he did not do, he probably would have made the same observations.

The reaction was also studied on a small and large scale by the American Chemical Warfare Service, and while it was able to work out a satisfactory process, it was very glad to adopt the Levinstein "reactor" as soon as it was demonstrated; and in all reports, the American chemist was very careful to refer to it as Levinstein's process.

Williams (*J. Soc. Chem. Ind.*, vol. 38, p. 451R) calls attention to the fact that the H. M. Factory, Avonmouth, was also concerned in the development of Pope's reaction on a commercial scale, but it apparently did not accomplish the elimination of sulphur deposition, though it was recognized as an evil to be overcome.

According to Pope, England seems to have suffered from a lack of co-ordination of "scientific advisers" and technical men. Apparently all the scientific men were not consulted in the matter of the best method to be employed, although we believe that such men as Irvine were intimately connected with the early history of mustard gas. It must not be supposed, however, that their scientific advisers did not make use of their opportunities. Mention of mustard gas, of the new synthesis of diphenylchlorarsine and the discovery of D.M. is sufficient to show how very valuable their services were to gas warfare in general.

America was fortunate in that all of her chemists worked together and that finally a very complete organization was built up in the Chemical Warfare Service through the efforts of Major General Sibert. The success of this organization is evidenced by the gas program planned for the year 1918-1919.

May we not then give Sir William Pope the credit for having called attention to the one satisfactory method of preparing mustard gas, and for the laboratory demonstration of this reaction, and to the technical chemists of England and America, and especially to Levinstein, Ltd., for having surmounted the many factory difficulties in putting the reaction into the plant, and finally to the men of the Chemical Warfare Service of all countries for their faithfulness under conditions not always agreeable in its actual manufacture?

Current Activities of the Bureau of Mines Stations

THE investigations conducted at the various stations of the Bureau of Mines are of interest in that they reflect the problems that are confronting the mineral industries and the trend of metallurgical developments in this country.

BERKELEY (CAL.) STATION

The Berkeley Station is investigating the reaction between silver chloride and water vapor and between metallic silver and hydrochloric acid. This is in connection with the volatilization of the chlorides of silver, copper, lead and zinc as a means of recovering these metals from ores that are not amenable to usual metallurgical methods. This latter problem is being studied in detail by the metallurgists at the Salt Lake City Station. The Berkeley Station is also working in co-operation with the Northwest Magnesite Co. on the problem of producing caustic magnesite from deposits which occur in the Western States. It has first been necessary to standardize and improve technical methods of analysis and to perfect an exact method for the determination of calcium. Work is also being done to determine the effect of the time-temperature-size-of-particle factors in the calcination of magnesite and in determining the tensile strength of magnesian mortars.

BARTLESVILLE (OKLA.) STATION

The work at the Bartlesville Station is primarily in connection with the problems related to the production and refining of petroleum and natural gas. The losses due to evaporation in the storage of oils are being studied in the Oklahoma, Texas and California fields. The reduction of the loss is of importance in view of the increasing demand for gasoline. The losses which occur in the fire distilling of mineral seal oils are also being investigated. The heating value of gases that have been treated for the recovery of gasoline is being compared with that of untreated gas. Field work covers investigation in various oil and gas fields.

COLUMBUS (OHIO) STATION

Ceramic investigations are being conducted at the Columbus Station. The comparative qualities of bond clays in the production of graphite crucibles used in the melting of brass and steel have been determined. Further investigations are to be undertaken to determine the comparative value of American and imported graphite. Tests are conducted to determine the value of clays for different uses such as for pottery, building and fire brick.

FAIRBANKS (ALASKA) STATION

The Fairbanks Station deals with the minerals and ores from the Alaska district. Black sands in different localities are being tested for gold and platinum; where these metals are found in paying quantities, concentration methods are worked out. Black sands from Fairbanks Creek and from Goldstream are now being investigated. Methods for the separation of copper from pyrrhotite in ores from the Kennecott Copper Corp. at Latouche are being investigated. Custom assaying is also carried on at this station.

GOLDEN (COL.) STATION

At the Golden Station radium research is conducted. The spectra of krypton and xenon have been the subject of investigations by Dr. Moore and Dr. Lind of the station in co-operation with Prof. Nysander of Denver University. Dr. Marden of the University of Missouri has completed a monograph on the analytical methods of zirconium. Key West copper-nickel-platinum ore from Pioche, Nev., has been examined, and preliminary investigations indicate that a separation of the copper and nickel can be made by differential flotation and that 85 per cent of the platinum can be recovered. A co-operative agreement among the Primos Chemical Co., the Bureau of Mines and the Colorado School of Mines has been entered upon to conduct research work on molybdenum steels. The factors which influence the phosphorescence of zinc sulphide are being investigated by C. W. Davis. The production of a luminous paint from this material will help conserve the limited supply of radium. J. E. Conley is experimenting with a descloizite from Goodsprings, Nev. The removal of the vanadium from this low-grade ore carrying a highly calcareous gangue is being attempted by passing dry chlorine over the reduced ore at low temperature. About 85 per cent of the vanadium was volatilized without the calcite being appreciably attacked. Mr. Conley is also preparing a chapter on the analytical methods of vanadium.

MINNEAPOLIS (MINN.) STATION

The Minneapolis Station is erecting an experimental iron blast furnace, the blowing in of which has been delayed by the unusually early and severe winter weather. The Fuel Division has been working on the economical use of fuels common to the Northwest in house-heating units. The work has demonstrated that economy may be effected by proper burning of these fuels and the public has evidenced an appreciation of this work. C. E. Plummer is investigating the standardized methods of determining phosphorus in iron ores and the separation of manganese and magnesium in iron blast furnace slags.

PITTSBURGH (PA.) STATION

The work of the Pittsburgh Station in the physical testing of explosives and in the examination of explosives to be put on the permissible list is being carried on as usual. Messrs. Howell, Munroe, Rice and Hall have been appointed on a committee to consider the rules and regulations governing the testing and placing of explosives on the permissible list. An investigation is being conducted in co-operation with the New York and New Jersey State Bridge and Tunnel Commission to determine the amount and composition of exhaust gases in motor vehicles to obtain data for the ventilation of the proposed tunnels under the Hudson River. A new furnace and apparatus has been built for the study of the forms of coal sulphur carbonized at temperature of 500 deg. C. and over. Additional data are being gathered in regard to scrap loss in aluminum foundry practice and the available statistics are being correlated. Metallographic and chemical work in connection with typical defects in aluminum castings is being conducted. Methods for the analysis of aluminum and its alloys are being investigated. The Fuel Section is conducting boiler tests for the United States Emergency Fleet Corp. in determining the efficiency of oil-burning equipment.

SALT LAKE CITY (UTAH) STATION

The work on chloride volatilization is being continued at the Salt Lake City Station. Recent test runs on ore from Yellow Pine Mining Co. from the Goodsprings district in Nevada showed an extraction of 83 per cent of the lead and 88 per cent of the silver. In these runs salt was used as a chloridizing agent and powdered calcium chloride was introduced into the discharge end as a volatilizing reagent. Silver-lead residue from zinc retorts and oxidized copper ores are also being investigated to determine the adaptability of this method for recovery of the metals. Ore of the Tintic Standard mine was treated for the extraction of silver and lead in concentrated acid brine solution.

SEATTLE (WASH.) STATION

At the Seattle Station attention is being given the problem of the utilization of Washington coal. Fuel oil shortage has necessitated the use of the available coals from the district. Investigations cover the field of mining, washing, briquetting and the utilization of powdered coal. The co-operation work with the Idaho School of Mines at Moscow covers differential flotation experiments on lead-zinc ores and cyanidation tests of gold-silver ores from Idaho.

TUCSON (ARIZ.) STATION

At the Tucson Station co-operative work is being carried on with the Miami Copper Co. Equipment is being installed to investigate the leaching of low-grade copper ores by sulphur dioxide. Equipment at the Miami plant has been recently overhauled, a counter-current decantation system has been added for the clarification of copper sulphate solutions, also a Cone settlement apparatus for the recovery of precipitated copper. The production of sponge iron for the precipitation of the copper from solutions is being investigated. Dr. C. M. Bouton, of the Berkeley Station, has been detailed on special chemical investigations connected with SO_2 leaching problems.

URBANA (ILL.) STATION

The Urbana Station is investigating the coals of the Midwest field. W. W. Odell has submitted plans to the Chicago gas companies whereby improvement in operating efficiencies may be obtained.

SAN FRANCISCO (CAL.) STATION

The San Francisco Field Office is studying the problem of reducing the viscosity of heavy asphalt-base crude oil. The work is being conducted by C. P. Bowie and M. J. Gavin. Mr. Gavin is also investigating the problem of oil-shale development. A. R. Elliott is investigating the evaporation losses and changes in temperature of oil in storage.

A Test on Sulphur Content of Clean, Cold Producer Gas

By Carl F. Kaufmann

THE field of uses for clean, cold producer gas has broadened to such an extent that this gas is now bidding for the place long held by hot, raw gas in the making of steel by the open-hearth process. In this connection the presence of sulphur in the gas must be considered, as naturally a high sulphur content will have a deleterious effect upon the steel. The sulphur exists in the raw producer gas in three forms: hydrogen sulphide, carbon bisulphide and sulphur dioxide, but principally in the forms of hydrogen sulphide and carbon bisulphide in the proportion of about one of the former to two of the latter. The ratio varies with the character of the coal used.

The writer directed an extensive series of analyses conducted to ascertain the quantity of sulphur contained in the coal, the amount going down with the ash, the quantity carried over by the raw gas, the quantity absorbed by water in both the primary and secondary condensers, the quantity carried off in the tar, and the quantity that is finally present in the clean, cold producer gas.

At the start of the test the bunkers were stocked with a 24-hr. supply of coal, and during the test, approximate analyses were made from samples taken from the chutes to the producer, at intervals of two hours so as to insure a fair average representation.

The approximate analysis of the coal is given as follows:

	Per Cent		Per Cent
Moisture	1.37	Ash	9.59
Volatile and organic	36.23	Sulphur	1.81
Fixed carbon	51.00		
B.t.u. per lb., (calorimeter)			13,709

The quantity of coal burned in the producer was 58,900 lb. As the sulphur content of the coal was 1.81 per cent, the total sulphur present was therefore 1,066.09 lb. There was produced from burning the above quantity of coal 5,706.5 lb. of ash containing 92.5 per cent mineral and 7.5 per cent combustible matter. The sulphur present in the ash analyzed 0.16 per cent by weight, equaling 9.13 lb. Deducting this quantity from that contained in the coal leaves a total of 1,056.96 lb. carried off from the producer in 3,540,000 cu.ft. of raw gas to the primary condenser.

The volume of water supplied to the primary condenser in 24 hr. as indicated by a Bailey flow meter was 314,000 gal., to the secondary condenser 156,000 gal.

Analysis of the condenser water before using is given as follows:

	Parts per 100,000		Parts per 100,000
Silica	2.64	Calcium sulphate	32.78
Iron dioxide	0.14	Calcium chloride	38.03
Aluminum oxide	0.11	Magnesium chloride	23.30
Calcium carbonate	26.50	Sodium chloride	162.84

Analysis of the primary condenser water, determination made every 2 hr., averaged 14.4857 grains per gal., or for the total volume of water, 649.79 lb. The secondary condenser water showed an absorption of 14.3689 grains per gal.; for the total volume of water, 320.22 lb.

The quantity of tar distilled and separated by the extractors was 366.75 gal. delivered to the tar decanter. Taking the weight of tar as 8.336 lb. per gal., it will follow that the total weight of the tar equals 3,058.228 lb. The sulphur present in the tar analyzed 0.253 per cent by weight, or a total quantity of 8.737 lb.

The ultimate analysis of the gas showed a sulphur content of 0.1451 grain per cu.ft., or a total of 73.78 lb. contained in the 3,540,000 cu.ft. of gas produced.

Ultimate analysis of gas is given as:

	Per Cent		Per Cent
Carbon dioxide	5.00	Hydrogen sulphide	0.02
Carbon monoxide	23.20	Hydrogen	11.80
Oxygen	0.60	Nitrogen	54.18
Methane	5.20		

RECAPITULATION

Duration of test, hr.	24
Coal consumed, lb.	58,900
Ash produced, lb.	5,706.5
Tar distilled, lb.	3,058.2
Gas produced, cu.ft.	3,540,000
Water consumed, primary condenser, gal.	314,000
Water consumed, secondary condenser, gal.	156,000
Temperature water entering primary condenser, deg. F.	58
Temperature water leaving condenser, deg. F.	125
Temperature gas entering condenser, deg. F.	1,000
Temperature gas leaving condenser, deg. F.	120
Temperature water entering secondary condenser, deg. F.	58
Temperature water leaving secondary condenser, deg. F.	72
Temperature gas entering condenser, deg. F.	124
Temperature gas leaving condenser, deg. F.	68
Sulphur content in ash, lb.	9.13
Sulphur content in water primary condenser, lb.	649.79
Sulphur content in water secondary, lb.	320.22
Sulphur content in tar, lb.	8.74
Sulphur content in gas (ultimate analysis), lb.	73.78
Sulphur content unaccounted for, lb.	4.43
Sulphur content in coal, lb.	1,066.09
Sulphur content in gas, grains per 100 cu.ft.	14.31

Crucible Steel Co. of America.

Aluminum in Norway

ACCORDING to a report by R. B. Ladoo of the Bureau of Mines (Monthly Reports of Investigations, December, 1919), Norway has not previously been a producer of aluminum, having been wholly dependent upon imports, but during the war the Hoyangfaldene Co. was formed to undertake domestic production. Jetland Falls, from which the Hoyanger plant obtains its power, furnishes an available 80,000 hp., of which 30,000 hp. has been utilized at a cost of 6,708,207 kroner ($1,811,-215.90 at the normal exchange rate). It is estimated that the total development cost for the whole plant installed will be 300 to 350 kroner ($80 to $95) per hp. The whole enterprise includes works which will produce 7,000 tons of metallic aluminum, 5,000 tons of electrodes and 12,000 tons of carbide.

No sources of bauxite are known in Norway, but the company is affiliated with the Société des Alumines & Bauxite de Provence, of France, which owns adequate sources of bauxite.

In the meantime the Hoyangfaldene Co. has been manufacturing electrodes, carbide and iron and has been experimenting on a large scale with domestic raw materials to discover a local source of aluminum ore, and it is reported that results are encouraging.

Alumina From Labradorite

In this connection it is of interest to note that the development of a process of extracting alumina from labradorite has recently been reported from Norway. The process involves the solution of labradorite in dilute nitric acid made locally, leaving the impurities as a residue; evaporation and heating to a point at which the aluminum nitrate alone is decomposed, and dissolving the calcium and sodium nitrates in water, leaving pure aluminum oxide. Labradorite, as ordinarily found in this country, is not sufficiently soluble in nitric acid to make this process seem feasible on a commercial basis; but it is possible that the Norwegian material is not a true labradorite and is much more soluble. Pure labradorite contains about 30 per cent alumina or 16 per cent aluminum.

Aluminum Rolling-Mill Practice—II
Melting Furnaces—Ingot Pouring

Continuous Versus Intermittent Melting, Prior to Casting Rolling-Mill Ingots, Is Discussed by the Authors in Their Second Installment—Correct Melting and Pouring Practice for a Minimum of Drossing Is Also Indicated*

By ROBERT J. ANDERSON and MARSHALL B. ANDERSON

FOR casting into rolling ingots, aluminum is melted in gas- or oil-fired (and occasionally coal-fired) furnaces of the open-flame reverberatory type, and in electric furnaces. Ordinarily, open-flame gas-fired furnaces are preferred; the firing is accomplished by the combustion of the fuel ejected from burners and with the aid of air. A typical gas-fired furnace is one of 5,000-lb. capacity (2,300-kg.), and such a furnace will consume about 1,000 cu.ft. of natural gas per hr. (28 cu.m.) under the conditions of fast melting practice. Gas- and oil-fired furnaces for melting aluminum for casting into rolling ingots are represented by a number of common types, for example the Rockwell, and no lengthy description will be given now. The usual furnace is built with a refractory hearth or bottom of firebrick and with inside walls and roof of the same material. The outside walls are made of common brick; the whole furnace is bound firmly together with channels or I-beams and stay rods. There may be two or more burners to a furnace; one type has two burners, one at the front situated so that the flame is about 12 in. (30 cm.) above the bath, and the other at the rear but about 30 in. (75 cm.) above the bath. Melting furnaces using gas or oil for fuel may be built in pairs, i.e., the side of one furnace abuts the side of another. Charging and cleaning are accomplished through a door at one side, and the metal is tapped through a tap hole at the front.

Coal-fired furnaces have been used for melting aluminum, but there are certain definite disadvantages which arise with the use of these furnaces. They are built with a firebox at one end; the flame sweeps over a bridge wall and across the metal, and finally out through a stack. One difficulty in the use of coal lies in the lack of anything like accurate control of temperature. From the rolling mill standpoint, another disadvantage lies in the fact that metal melted in coal-fired furnaces is usually more dirty and discolored than metal which has been melted in gas-fired or oil-fired furnaces. This statement is based upon inspection of ingots, slabs and sheets.

USE OF ELECTRIC FURNACES

Electric furnaces have lately received some attention in the United States for aluminum melting. In particular, the Baily resistor furnace[6] has been used for this purpose. Offhand, electric furnaces might appear to be entirely unsuited to aluminum melting because of the fact that high temperatures are usually associated with these furnaces. Arc furnaces do not appear to be desirable appliances for aluminum melting, but resistor-type furnaces apparently have some advantages. Even though aluminum melts at a rather low temperature, it may be considerably superheated in a neutral atmosphere without ill effects or large volatilization losses because the boiling point[7] is quite high: viz., 1,800 deg. C.

It is assumed by some that reducing atmospheres follow from the use of electric-arc furnaces or electric-resistor furnaces using a carbon-base resistor. A reducing atmosphere will not be obtained in these furnaces unless the furnace is tightly luted so as to prevent ingress of air, and the average furnace will not be operated in this way. With resistor-type furnaces, better control of temperature is possible than with either gas-, oil- or coal-fired furnaces. A neutral or reducing atmosphere is rather difficult to maintain in gas- or oil-fired furnaces under the conditions of melting.

With regard to furnace atmospheres, there is this to be said: Under the usual conditions involved in charging continuous heats the doors are open for such a considerable portion of the time that no particular atmosphere could be maintained very long.

MELTING FOR MINIMUM DROSS

A usual method for melting aluminum prior to ingot casting, in reverberating furnaces, calls for charging into a hot furnace, say, 5,000 lb. (2,300 kg.) of cold metal, i.e., pigs alone or plus scrap. When the charge is melted, ingots are poured until the furnace is empty. This is a rather uneconomical procedure in the case of 24-hr. practice. Aluminum is readily oxidized in the presence of air and rapidly with increasing temperatures. Under the above conditions, a large surface area of metal is exposed to both air and a free flame; this normally results in high dross losses. If reducing conditions could be positively and completely under control at all times, then the case would be altered.

Dross, in aluminum melting practice, is understood to consist of aluminum oxide (Al_2O_3 or some other oxide) plus metallic aluminum mechanically entangled. Dross losses resulting from poor melting methods have, at times, amounted to as much as 3 per cent of the total metal charged, but this, as shown later, is an excessively high figure for good practice.

In order to melt aluminum for ingot casting, a method more to be preferred than the one above is as follows: To a hot furnace, charge about 500 lb. (230 kg.) of pig metal, and when this has been melted continue adding more pigs from time to time until the whole charge has been put in. After each addition the cold pigs should be put down below the surface of the

*For Part I see CHEM. & MET. ENG., vol. 22, No. 11, p. 489, March 17, 1920.

[6]Dwight W. Miller, "The Remelting of Aluminum Pig in the Electric Furnace," CHEM. & MET. ENG., vol. 19, 1918, pp. 251-254.

[7]Smithsonian Physical Tables, 1918, p. 218.

bath, and sufficient time should be allowed for them to melt before adding more cold metal. There will be no difficulty in keeping the cold metal under the surface, because the density of liquid aluminum is less than that of solid aluminum. In this way the smallest possible surface is exposed to the action of the flames, and oxidation is kept lower than otherwise.

If the endeavor is made to keep the temperature of the bath low in order to avoid gas absorption, excessive oxidation, and the formation of aluminum nitride, then too much cold metal should not be added at one time, or the whole bath may freeze. Normally, however, there is not an accurate control of the bath temperature, and usually the bath will be sufficiently hot so that several hundred pounds of cold pigs can be charged at intervals of one hour.

Aluminum melting may be either intermittent or continuous; in the former a furnace is charged, and the metal is melted in the manner just described; the entire melt is then poured into molds, the furnace is recharged, and the whole operation is repeated. In continuous melting, a furnace is started as in intermittent melting, and additional metal is added from time to time (usually every hour or so) in order to keep pace with the rate of ingot pouring. In this method, a furnace is always practically full of metal, but it presupposes 24-hr. operation unless it is desired to hold a bath of hot metal over night. This latter is hardly advisable, since furnace breakouts might occur.

CONTINUOUS MELTING

A continuous heat may run for about one week, being started on Monday and continuing until the end of the week, when the furnace is emptied and cleaned. For an example, it may be assumed that a 5,000-lb. heat is in the furnace in the liquid condition and that pouring of ingots has commenced. It is the duty of the furnace fireman to keep the furnace full of metal and at a sufficiently high temperature at all times so that ingot pouring will not be delayed. In order to do this, he should keep account of the number of ingots poured during a given time, say 1 hr.; at the end of that time sufficient pig or scrap, or both, should be added to replace the metal already tapped from the furnace. Thus, if there had been poured ten ingots of the 4 x 12 x 17-in. size (10 x 30 x 43-cm.), weighing approximately 76 lb. (35 kg.) each, the fireman should add twenty-three pigs of the 33-lb. (15-kg.) size, or an equivalent weight of pig plus scrap. If the additions are not made at regular intervals, too much cold metal may be charged at one time and the bath will be unduly chilled.

For practical purposes, in the case of a 5,000-lb. (2,300-kg.) furnace, the danger limit is 3,500 lb. (1,600 kg.) of metal in the furnace. If the bath is allowed to fall below this amount, the fireman will not be able to keep the furnace at a high enough temperature so that ingots may be poured continuously. This trouble soon culminates and stops production. When less than about 3,500 lb. of hot metal at the correct temperature is in the furnace, not more than twenty-five cold pigs of the 33-lb. (15-kg.) size can be charged at one time, since otherwise the bath will be unduly chilled; it will require at least 60 min. for 800 lb. (350 kg.) of cold pigs to go into solution, and in that time about 800 lb. of aluminum will have been poured into ingots. It will again not be feasible to charge more cold metal for another hour, and in the meantime more ingots

will have been poured. Hence the difficulty becomes cumulative, and if the cold metal is not charged at regular intervals to keep pace with the rate of pouring, production on the furnace must be stopped in order to allow time for the bath to regain the correct pouring temperature. In short, the rate of charging cold metal, in continuous melting, should correspond closely with the rate of pouring, with the object of maintaining the temperature of the bath reasonably constant.

The relative merits of continuous and intermittent melting may be summed up as follows:

(*a*) In small plants or where the production is irregular, or elsewhere if the melting capacity is greater than the rolling capacity, intermittent melts will be employed.

(*b*) Intermittent melts give more uniform ingots, as to composition, when mixed pig and scrap, or all scrap charges, are run.

(*c*) Intermittent melts may possibly have some advantages in that they allow better separation of dross. The evidence is not entirely clear on this point, but more uniformity in the subsequent sheets is usually found.

(*d*) On the other hand, continuous melts are cheaper from the standpoint of fuel consumed and labor employed.

(*e*) Continuous melts give greater production for a given melting capacity.

INTERMITTENT MELTING

The above remarks refer to either reverberatory-type or electric-furnace melting. In order to avoid the less efficient night work, a small plant will cast ingots only by day. For large plants where the production is irregular, it will not be advisable to run the melting department at capacity when the rolling and fabricating departments are not at capacity also. Again, if the melting capacity is out of proportion to the rolling capacity, e.g., larger, then it is advisable to melt intermittently, because in this way the melting can be so carried out as to keep pace with or be a little ahead of the rolling.

Greater uniformity of ingot composition can be obtained by intermittent melting, for the reason that it is possible to obtain separate lots of metal of practically the same composition. It is difficult to keep scrap assorted according to lot, and the pig composition itself may be somewhat variable. Lots of scrap from slab shearing can readily be kept separated, but it is more difficult to segregate shearings on finished sheet and pack trimming, and practically impossible to keep any accurate account of small fabricating scrap by lots.

With intermittent melts, more men must be employed at short intervals for charging; with continuous melts, one man could charge two furnaces and be kept busy most of the time. Melting furnaces are charged by hand, and the labor is not severe.

Time required for melting a cold charge of aluminum varies with type of furnace, character of the charge, and with available working temperature of the furnace. Electric furnaces will melt aluminum more rapidly than will open-flame furnaces, for the self-evident reason that higher temperatures can be obtained. Medium scrap in the loose or baled condition will melt more rapidly than massive pig metal.

In order to give a specific idea of the time required to melt aluminum charges under mill conditions, there may be considered a gas-fired furnace of 5,000-lb. (2,300-kg.) capacity. Starting with a cold furnace, it

requires 6 to 10 hr. to heat the interior to 900 deg. C.: if pig metal be then charged as fast as it will melt, it will require about 4 or 5 hr. more to melt 5,000 lb. of aluminum and superheat it sufficiently for casting.

It also takes time to remove as much of the already formed dross as possible before starting to pour ingots. Consider the case of an open-flame reverberatory furnace of 5,000 lb. capacity, it being also assumed for purposes of illustration that the furnace is run continuously during the day, that no ingots are poured at night, and that a capacity heat is put in the furnace over night. In the morning, the day fireman should clean the bath before any pouring is started. Cleaning may be accomplished by the use of about 5 lb. of zinc chloride, $ZnCl_2$, to a 5,000-lb. heat. This reagent should be placed in a long-handled ladle and run back and forth through the bath from one side of the furnace to the other, below the surface. The bath should then be stirred vigorously with a long-handled pointed prong in order to insure thorough mixing of the zinc chloride. After allowing the melt to stand for about 10 min., the accumulated dross on the surface may be removed by a skimmer. While the value of zinc chloride is still a matter of contention among aluminum melters, it appears to be of some advantage for cleaning aluminum heats before ingot pouring.

REMOVING MOLTEN METAL

One feature of aluminum-melting furnace design which is of interest lies in the provision for removing the metal from the furnace to the pouring crucible. In general, there are two ways in which this may be accomplished; first, by tapping the metal through a tap hole and runner, and, second, by ladling the metal out through a door. Of the two methods, the former is to be preferred. In tapping, the tap hole has been previously plugged with a 50:50 dough-asbestos ball on the end of an iron-handled cone; to tap, the cone is pulled out of the hole, and the metal flows down the runner. The hole is then replugged with a new ball. Difficulties occasionally arise by the metal freezing up around the tap hole; this is more often due to poor design of the tap hole than to the method itself.

Ladling is very bad practice, in the opinion of the writers. The ladle is usually hung on a swing at one of the furnace doors, and the metal is ladled out until sufficient has been placed in the pouring crucible. In this way there is more opportunity for the metal to cool than when tapping; further, it is much slower. In addition, there is more opportunity for dross to become entangled with the pour because several ladlesful are necessary to fill the pot; each ladle of metal will be more or less covered with dross. It is possible that there may be some advantages in using large tilting crucible furnaces for aluminum melting; such furnaces would empty more easily than either tapping or ladling, and there would be less opportunity for overheated melts.

TEMPERATURE CONTROL

Pyrometric control of aluminum-melting furnaces has apparently not been applied to any considerable extent, but definite advantages would follow from the control of melting temperatures. There have been certain difficulties in the way of pyrometric control of aluminum melting, but these are not insuperable. In open-flame furnaces, iron-protection tubes break down rather rapidly under the flame action, while alundum and silica tubes are too fragile for heavy duty. Irrespective of what kind of thermocouples are used for taking temperatures, there is the liability that they will be damaged during charging if they are kept in the furnace at all times. Thermocouples have been permanently installed, on some furnaces, in the roof or side walls, or both; the recorded readings do not furnish the temperature of the bath of course, but may be more or less useful. These readings may be supplemented by taking the actual bath temperature at regular intervals by means of a portable pyrometer. At the present time, it appears that the most reliable and simplest method of pyrometric control of aluminum melts is to take temperature readings every 30 min. or so with a portable pyrometer. Aluminum is cast into rolling ingots at 700 to 760 deg. C., the temperature depending upon the size of the ingots.

DROSS

As has already been noted, one of the principal sources of metal loss in aluminum melting is that resulting from oxidation according to

$$2Al + 3O = Al_2O_3$$

or possibly

$$3Al + 4O = Al_3O_4$$
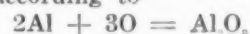
Prevention of oxidation is one of the main difficulties with which aluminum melters have to deal. Whether the oxidation is due to an oxidizing flame, or to air entering the furnace when the doors are opened or through cracks, does not alter the final result. The specific gravity of aluminum oxide, Al_2O_3, is 3.73 to 3.99, that of the amorphous oxide being 3.85; it melts at 2,020 deg. C. Since aluminum oxide has a greater density than liquid aluminum, the tendency for the oxide formed would be to sink to the bottom of a bath and collect there; the viscosity of the metal may prevent such a separation in part, and surface tension can help in maintaining an oxide scum on the bath surface. Moreover, the possibility of aluminum oxide being soluble in aluminum should not be overlooked. Consideration of these factors, however, is liable to lead to speculation, and the fact is that the necessary information is lacking as to what actually takes place during dross formation in melting practice.

For the purpose of the present article, it is sufficient to know that the most serious losses in aluminum melting result from oxidation, and that care should be taken to guard against excessive dross losses. That excessive dross losses may be prevented by fairly simple precautions will be shown. In practice, it is found that whenever a furnace is emptied a considerable amount of dross has collected on the bottom; cleaning the furnace practically amounts to scraping out this accumulation of dross. During melting, aluminum oxide is probably being formed continuously, and it appears that part of this oxide finds its way to the bottom of the bath, given sufficient time. In some instances, the dross collected at the bottom of the bath has been removed by scraping it out through the bath in order to prevent it from being carried into the pouring crucible on tapping; much aluminum is also removed in this way, and it is doubtless better to remove dross by cleaning the bath with zinc chloride before pouring and then clean out the furnace after all the aluminum has been tapped and the furnace drained of metal. During the pouring of ingots, the bath also should be scraped off every 2 hr. or so with a skimmer to remove the surface dross. The use of zinc chloride for cleaning

melts has already been described. On a 5,000-lb. (2,300-kg.) intermittent heat, about 50 to 100 lb. (23 to 46 kg.) of dross will be removed from the emptied furnace, equivalent to 1 to 2 per cent by weight, in addition to the amount which is removed from the surface of the bath during pouring and that taken off the ladles.

This dross is not entirely aluminum oxide, but contains perhaps from 30 to 60 per cent metallic aluminum mechanically entangled with the oxide; the amount of metallics in dross depends upon the care with which the bath is skimmed. Dross also contains iron, silica, and other impurities. On continuous heats, the dross removed at the end of a week's run will be much larger in quantity, usually from 300 to 500 lb. (135 to 230 kg.), and the daily skimmings will amount to about 50 lb. (23 kg.) per day, or 300 lb. (135 kg.) in the week. Furnace dross has a salable value as such, and its price will depend upon its content of elemental aluminum and the condition of the secondary metal market.

GRADING MELTS

In what has gone before it has been shown how aluminum melting is either intermittent or continuous, and consideration is now given to various grades of furnace heats and the use of scrap aluminum in charges.

TABLE III. PERCENTAGES OF SCRAP AND PIG IN ROLLING INGOTS

Ingot Designation	Percentage of Pig	Percentage of Scrap
A	100 to 80	0 to 20
B	80 to 60	20 to 40
C	60 to 40	40 to 60
D	40 to 20	60 to 80
E	20 to 0	80 to 100

Aluminum-melting charges for ingot production are made up according to the quality of ingots desired, and they may vary more or less, depending upon local conditions, the amount and character of the scrap made in the plant, as well as upon the conditions existing in the aluminum pig and scrap markets. Rolling ingots may be designated by any suitable symbols, according to the percentages of contained scrap and pig metal. Thus, ingots may be designated as A, B, C, D and E, depending upon the relative proportions of scrap and pig in the furnace charges. Table III shows how the percentages of pig and scrap may vary, but the figures and the symbols are arbitrary; as a matter of fact, the relative percentages of scrap and pig may be anything from 0 to 100 per cent of each.

Strictly speaking, first-grade rolling ingots are understood to be ingots cast from an all-pig melting charge, or they may include ingots cast from a charge consisting of pig plus scrap originating in the manufacturer's own plant and of a composition not differing markedly from the composition of the pig. All-scrap ingots are made from an all-scrap charge. Usually varying amounts of scrap are charged together with pig metal.

All-pig ingots will have practically the same chemical composition as the original pig metal, but there is usually a higher silicon content due to reduction of SiO_2 from the furnace lining by the aluminum. With increasing percentages of scrap in the charge, the aluminum content of the ingots becomes lower and lower, and all-scrap ingots seldom, if ever, contain 99 per cent Al.

Copper, brass, iron, steel, etc., may become mixed with aluminum scraps, particularly the lighter ones; hence, on melting, zinc may be introduced, copper and

iron will be increased, and other impurities may find their way into the resultant ingots, depending upon the nature of the contaminating materials. The common aluminum-mangenese alloy, containing about 1.50 per cent Mn, and employed for so-called "hard sheets," may also become mixed with aluminum scrap, with a consequent introduction of appreciable amounts of manganese on remelting. In a word, it is practically impossible to guard against the contamination of scrap under existing plant conditions. On the basis of a 99 per cent aluminum content for virgin pig, remelted scrap will rarely contain that much aluminum, and it usually contains about 98 per cent.

INFLUENCE OF IMPURITIES

The presence of certain impurities, in subordinate amounts, appears to cause no particular harm, at least so far as rolling is concerned. However, it is a fact that ingots cast from high scrap content charges, such as D and E in Table III, usually contain more occluded dross than A ingots; and sheets rolled from the former never appear to have so good a surface appearance as those rolled from A ingots. D and E ingots are rarely used for sheet rolling, and if used at all should be worked into strip rolled metal. The lower grade ingots will split more readily than the higher grade ones on rolling, but strip metal is drawn out rather than spread, so that D and E ingots may be utilized for this.

In commercial mill practice, furnace charges will be made up according to the grade and quality of the sheets demanded, whether strip is made or not, and whether specifications are called for or not. Specifications for sheet aluminum will be included later.

POURING PRACTICE

Generally speaking, the size of ingot to be poured will depend upon the size of sheets to be rolled, and

TABLE IV. DIMENSIONS AND WEIGHTS OF ALUMINUM ROLLING INGOTS

Ingot dimensions, in.	Calculated weight[1] lb.	Actual average weight,[2] lb.
4 x 12 x 17	79.5	75.5
3.5 x 12 x 20	81.4	79.0
3.5 x 12 x 21	85.9	86.5
3.5 x 12 x 22	90.0	89.0
4 x 12 x 20	93.0	90.0
4 x 12 x 21	98.0	94.5
3.5 x 12 x 24	98.0	95.0
4 x 12 x 24	112.2	107.0
4.75 x 11.75 x 22	119.6	114.5
4 x 12 x 27	126.3	121.0
4.75 x 11.75 x 24	130.5	123.5
4 x 12 x 30	140.3	135.0
7 x 16 x 24	261.9	259.0
7 x 16 x 26	305.5	300.0
7 x 16 x 30	327.4	315.0
7 x 16 x 36	392.8	366.0

1 in. = 2.54 cm.; 1 lb. = 0.454 kg.

[1] Calculated for ingots of the dimensions indicated and based on specific gravity = 2.70

[2] The actual average weights given are based on figures obtained by weighing a number of ingots from a given set of molds. The actual weights are less than those calculated, because the molds did not have the exact dimensions given. Furthermore, when speaking of a 4 x 12 x 17-in. ingot, for example, reference is had to the inside dimensions of the mold into which the ingot was poured. Shrinkage on freezing, blowholes, occluded gas, variation in filling the molds, and the fact that the molds were not exactly the same size as the dimensions indicated for the ingots account for the apparent discrepancies.

this matter, knowing the scrap allowances for shearing, is one of simple mathematical calculation. Ingots are poured as a rule in the sizes tabulated in Table IV, but any size can be cast according to the requirements. In any plant, the ingot production is governed not only by the melting capacity but also by the number of available ingot molds, since a mold can be used only once every 30 min. on the average, unless provided with a water

circulating cooler, when it can be used every 9 or 10 min. Aluminum ingots are cast in cast-iron chill-molds of proper dimensions.

In ingot-casting practice, as carried out at present, the melting furnace, if stationary, is tapped by withdrawing a plug filling the tapping hole at the front of the furnace. The metal then flows down an iron runner into the pouring crucible. When the crucible (a No. 125 to No. 200 in size) is about three-quarters full, or contains sufficient metal to pour one ingot of the desired size, the tap hole is plugged, and the stream of metal is shut off. This plug consists simply of a conical iron tool with an iron handle, and a 50:50 dough-asbestos ball is stuck on the point of the cone. Pouring crucibles are also filled by ladling out the aluminum from the furnace through one of the doors, the ladle being supported on a swing. With the ladle ordinarily used, it requires three or four ladlesful to fill a crucible. This method of filling crucibles is to be regarded as bad practice, because there is more opportunity for dross to become tangled in the metal.

Whether the metal is tapped or ladled, the surface of the aluminum in the pouring crucible should be skimmed before pouring. The pouring crucible when filled is conveyed by hand, or on an overhead monorail with hoist, to an adjacent battery of ingot molds drawn up into position by a chain hoist. The molds are tilted at an angle of 70 to 90 deg. with the horizontal. Pouring is accomplished by allowing the aluminum to run into the tilted mold, and at the same time lowering the mold slowly back and down to its original vertical position, so that as the mold finally assumes this position pouring is complete, and the mold is full of metal. An even stream of metal should be maintained from the crucible to the mouth of the mold; as the mold is lowered, the crucible is raised, and in this way the required condition is maintained until the mold is full. This procedure is followed so as to avoid splashing, for the metal can thus be made to flow down one side and thus fill the mold evenly.

Correct Feeding of Iron Molds

Aluminum has a relatively high coefficient of contraction, and in order to avoid piping, the mold must be continually fed at the head until the entire ingot is frozen. Feeding is accomplished with a hand ladle by adding hot metal from the liquid aluminum remaining in the crucible. Aluminum freezes very rapidly in chill molds, so that feeding at the head must be fairly rapid in order to keep pace with the contraction. When the metal has frozen, the molds are knocked open, and the ingots are removed.

Ingots are sometimes rolled directly from the molds, but more often are allowed to cool and then preheated before rolling. That the latter is a more rational procedure will be shown later.

Iron molds, as already mentioned, can be used, on the average, about twice in an hour, unless they are water cooled by circulating water. If not cooled in this manner, cooling may be hastened, apparently without any ill effects upon the molds, by "swabbing" them inside and out with cold water. It is more advisable to have the molds provided with a circulating water-cooling attachment. Molds should always be swabbed out on the inside with water after pouring each ingot so as to prevent accumulation of "fuzz" and insure that the surfaces of the ingots will be smooth. A swab can be made by tieing a ball of rags on a stick.

Some idea of the output of an average ingot-casting plant may be derived from the following figures: With an equipment consisting of 24 molds of the 4 x 12 x 17 in. (13 x 30 x 43 cm.) size and two 5,000-lb. (2,300-kg.) melting furnaces, five men can cast about 200 ingots in a day of 10 hr. It may be assumed that there are two men working on the furnaces, one melter and one helper. The melter will be charged with keeping the heats in good condition; the helper may spend most of his time with the ingot-casting crew. With twenty-four molds set up in two batteries of twelve each, there will be one man on each battery of molds. These men will remove the ingots after pouring, swab out the molds, and prepare the molds for the next pouring. Two men will be used for casting the metal, and the furnace helper will tap the furnaces. Daily production will vary, of course, with local conditions. For example, if ingots are rolled directly from the molds, the casting should be so arranged as to keep pace with the rolling. As has already been intimated, rolling directly from the molds is a rather dubious practice, and, as will be shown later, is not to be recommended.

1.5 Per Cent Manganese-Aluminum Ingots

Before dealing with the mechanical treatment of aluminum, a little space will be given to a consideration of the production of 1.5 per cent manganese-aluminum alloy ingots. As has been mentioned above, an alloy of this composition is rolled for the purpose of making so-called "hard sheets." These sheets are rolled for particular purposes where more strength is required than substantially pure aluminum can provide.

This alloy is rather troublesome to make, mainly because of the wide difference in melting points of aluminum and manganese, the usual procedure being to employ a 25:75 Mn-Al alloy for the purpose of introducing the manganese. Such an alloy can be purchased in the market or made up in the plant; it is economical to make the alloy as needed if much 1.5 per cent manganese-aluminum sheet is to be rolled.

On the assumption that a 25:75 Mn-Al alloy is used for introducing the manganese, the procedure to be followed in the production of ingots is substantially this: On the basis of a 5,000-lb. (2,300-kg.) heat, part of the aluminum (pigs and scrap) should be first melted and superheated. Then an addition of the 25:75 Mn-Al alloy should be made; either all or part of the rich alloy may be charged at this stage. The bath should be thoroughly stirred and churned to insure alloying and to prevent segregation. Then more aluminum and more of the rich alloy (provided it has not all been put in) should be charged from time to time until the whole charge is liquid. It is advisable, in making a large heat of the 1.5 per cent manganese-aluminum alloy, to charge into the melting furnace approximately enough of the rich alloy to produce a final alloy of the composition desired, as may be found by simple calculation. On the supposition that a 5,000-lb. heat is melted, then 300 lb. (135 kg.) of the 25:75 Mn-Al alloy would be charged. Samples of the melt should be taken before casting and sent to the chemical laboratory, where the manganese content can be determined in 15 to 20 min. In general, it is better practice to aim for a slightly higher manganese content than that actually desired, and then reduce it by later additions of Al, rather than to have the Mn too low, because of the difficulty in incorporating manganese.

TABLE V. MELTING RECORD[1]

Month	Pig	Rolling-mill scrap	Utensil scrap	Baled scrap	Furnace scrap	Outside scrap	Total metal charged	Rolling ingots	Furnace scrap[2]	Dross[3]	Per cent loss[4]
		Consumption of Metal in Pounds						Production in Pounds			
January	57,871	64,182	5,375	2,701	368	995	131,492	128,925	356	1740	1.68
February	54,550	89,377	3,727	2,508	300	.....	150,462	147,540	305	1729	1.74
March	43,549	68,175	3,879	2,241	401	3,791	122,036	120,360	530	1622	0.94
April	72,782	63,506	5,781	2,052	1,238	3,004	148,363	145,101	1,291	1997	1.33
May	115,475	67,423	5,368	4,160	2,165	9,980	204,571	199,205	2,154	3262	1.57
June	77,330	72,115	6,850	3,225	1,802	14,990	176,312	170,810	2,276	3820	1.83
July	56,268	61,309	4,055	3,790	1,250	1,023	127,695	124,739	1,255	1952	1.33
August	104,105	76,995	3,037	2,889	1,851	764	189,641	183,861	1,807	3011	2.10
September	97,591	69,300	2,671	2,390	1,635	2,044	175,631	172,264	1,872	2785	0.85
October	124,269	74,741	2,574	1,454	1,765	512	205,315	199,870	1,735	2811	1.81
November	99,680	83,774	....	....	568	3,432	187,454	183,746	1,770	2907	1.57
December	11,368	121,214	8,750	4,661	270	1,252	147,515	144,505	279	3312	1.85
Totals	914,838	912,111	52,067	32,071	13,613	41,787	1,966,487	1,920,926	14,630	30,948	1.57

[1] Based on the performance of one 5,000-lb. gas-fired, open-flame furnace (1 lb. = 0.454 kg.)
[2] Furnace scrap includes drippings, splashings, sweepings, etc., in the melting room
[3] Dross was weighed as such; metallics vary from 30 to 60 per cent.
[4] The figures for per cent loss are based on calculations derived from the formula

$$\frac{\textit{Weight of total metal charged} - (\textit{weight of rolling ingots} + \textit{weight of furnace scrap})}{\textit{Weight of Total Metal Charged}}$$

The necessity of keeping accurate records for the melting room will be readily apparent, and in fact, no systematic cost finding system can be applied to the plant if the melting records are neglected. Since balance sheets are customarily drawn each month, it may be advisable to keep monthly melting records; the results of the day-to-day performance can be readily added and transferred at the end of each month. In devising any record for melting, it is well to be guided by the principle that simplicity will prevent confusion. The essential data will include the amount of metal charged, the amount of ingots poured, the dross weight, and the shrinkage. Metal charged should be classified according to kind, i.e., pig, rolling-mill scrap, fabricating scrap, furnace scrap, scrap purchased outside, etc.

Table V shows a year's record for one 5,000-lb. (2,300-kg.) furnace in the melting room of a plant which operated a rolling mill and a utensil plant, during which time both intermittent and continuous melting were employed. Consumption of metal in pounds refers to the amount of metal charged into the melting furnace; the metal charged is classified as pig, rolling-mill scrap, utensil scrap, baled scrap, furnace scrap and outside scrap. In the present record, pig was mainly in the form of 33-lb. (15-kg.) four-notch bars, but some 3-lb. (1.4-kg.) six-notch ingot was also charged; rolling-mill scrap was made up of sheet and slab shearings from re-squaring operations and of defective sheets; utensil scrap consisted of defective utensils and large scrap from the utensil plant; baled scrap was baled hay, chips and trimmings from the utensil plant; furnace scrap consisted of splashings, floor sweepings and drippings occurring in the melting room on casting ingots; and outside scrap was made up of scrap purchased from outside sources, and was in various forms of light scraps. Production refers to the output of the melting furnace, and is made up of rolling ingots, furnace scrap and dross. A month's collection of furnace scrap was recharged early in the subsequent month. Dross consisted of the scrapings resulting from cleaning out the furnaces and skimmings from the furnace heats. Strictly speaking, there is also some flue scrap, where fine particles of metal admixed with dross are blown into the flues and collect there. In the case in hand, flue cleaning was done only at long intervals, and during the year one cleaning yielded 1,176 lb. (534 kg.) of flue dust.

Since the true metallic content of the dross cannot be accurately estimated, due largely to the difficulty in sampling this material, figures for losses are rather uncertain. Various methods are used for determining the shrinkage on melting, none of which are entirely satisfactory.

CALCULATION OF LOSSES

In Table V, the loss has been calculated from the formula

$$\frac{\textit{Wt. metal charged} - (\textit{Wt. metal poured} + \textit{scrap})}{\textit{Wt. metal charged}}$$

Other figures have at times been based on the formula

$$\frac{\textit{Wt. metal charged} - (\textit{Wt. metal poured} + \textit{dross} + \textit{scrap})}{\textit{Wt. metal charged}}$$

Figures derived from both formulæ are liable to be exceedingly erroneous, and it appears to be better to assume a definite metallic content for the dross. By so doing, a nearer approximation to the shrinkage can be obtained. Thus, if the dross contains say 40 per cent metallic aluminum, closer figures would result from the use of the formula

$$\frac{\textit{Wt. metal charged} - (\textit{Wt. metal poured} + \textit{scrap} + 0.40 \textit{ dross})}{\textit{Wt. metal charged}}$$

than would be obtained from the first two formulæ.

(Part III, dealing with ingot heating and mill calculation, will be published in our next issue.)

Four Billion Dollar Balance of Trade

The excess of American exports over imports in 1919 amounted to $4,017,000,000, a new record, according to a statement issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce. Exports for 1919 totaled $7,922,000,000, as compared with $6,149,000,000, while imports were valued at $3,904,000,000, against $3,031,000,000 in 1918.

December exports amounted to $681,000,000, a falling off from the $741,000,000 recorded for November. Imports also fell off for December, the total being $381,000,000, as compared with $425,000,000 for November. Both exports and imports were higher than in December a year ago.

The imports of gold in 1919 amounted to $77,000,000, compared with $62,000,000 in 1918 and $552,000,000 in 1917. Exports of gold in 1919 jumped to $368,000,000 from $41,000,000 in 1918. In 1917 they amounted to $372,000,000.

No marked change was noted in the imports or exports of silver, receipts amounting to $89,000,000 and shipments to $239,000,000 in 1919.

Double Pipe Heat Interchangers[*]

A Study Establishing the Importance of the Factor of Film Velocity in the Helical and Straight Length Double Pipe Heat Interchangers—Effect of Varying Pump Pressure, Pipe and Overall Dimensions

By GEORGE A. RICHTER

THE chemical engineer is vitally interested in experimental data giving information on the flow of heat from one fluid to another through metal surfaces. Although many papers have been written on this subject, there is still room for a vast amount of experimental work to confirm established heat laws and to pry further into unknown regions.

George A. Orrok gives an excellent review of published information on conductivity experiments in the 1910 volume of the *Transactions* of the American Society of Mechanical Engineers. Most of the work so summarized refers to the surface condensation of steam, and although some of the deductions listed may be applied directly to a liquid-to-liquid heat interchange, the conclusions reached must be studied with due reservation. A host of formulas have been presented by experimenters for surface condensation. It is very probable that discrepancies in their results do not point necessarily to inaccuracy in work, but may give evidence that there are other factors involved which have not been recognized.

Although the experimental work upon which this present paper is based concerns only double pipe heat interchangers, using hot and cold liquids, a brief résumé of heat transference in general may not be out of place.

DEFINITION OF CONDUCTIVITY

Heat transference is conventionally expressed in terms of heat units transferred per unit of surface per unit of time per unit difference in temperature. In this country English units are employed. A given system has a certain conductivity (K) representing the number of British thermal units transferred per sq.ft. of surface per hr. per deg. difference in temperature between the hot and cold fluid. Mathematically this temperature difference is the logarithmic mean of the incoming and outgoing hot and cold liquid:

$$T = \frac{D_1 - D_2}{\log_e \frac{D_1}{D_2}},$$

where D_1 represents the difference in temperature at the beginning of the system and D_2 the difference at the end.

It is at best exceedingly difficult and probably impossible to cover all cases of such heat transference by means of a few well-selected formulas. A new condenser, or a surface heater of radically different design, always requires experimental investigation in order to learn more concerning the application of heat laws already in existence. Such investigation sometimes involves the fixing of new constants in equations already worked out for other types. Often it means the establishment of entirely new relationships.

PLANT CONSIDERATIONS

The conductivity, or K, of a system is a function of the rate of heat transfer in that system. Often the value of K is all-important in the design of new cooling or heating installations. There are cases, however, where other factors are equally important. In general, the design of a new interchanger involves the following plant considerations:

1. Conductivity, or K, of various types of units.
2. Capacity of interchanger in total B.t.u. per volume of space occupied.
3. Amount of fluids to be pumped or moved in other ways.
4. Power required.
5. Limiting temperatures of incoming and outgoing fluids.
6. Construction and determining cost of material, practicability, resistance to corrosion, etc.
7. Intelligence required in operation.
8. Physical and chemical characteristics of fluid to be heated and cooled.

Each problem is apt to present other phases for consideration, depending upon requirements. Sometimes one factor of those enumerated above is of paramount importance. Factors 2 to 8 as listed demand the application of engineering sense and judgment. The conductivity factor cannot be calculated from theoretical principles, and consequently most of the experimental work on cooling and heating systems is concerned with that end of the problem.

EFFECT OF VELOCITY OF LIQUOR

If the total cost of introducing or abstracting a given number of B.t.u. in a system is to be minimized, compensatory advantages and disadvantages must be carefully weighed. For instance, the engineer must decide whether it will pay him to raise the conductivity by increasing the velocity of the liquid. In order to make such a decision he must have experimental data showing the effect of liquor velocity on power consumption of pump as well as on conductivity realized. He knows in general that raising the velocity either of the hot or of the cold liquor will increase the conductivity. He also knows this increase in conductivity is not a straight line function of the power consumption involved. The above example is merely one of several which confront the engineer on any new cooling or heating installation. The more data available the less guesswork and worry result.

Several investigators have established equations showing the effect of velocity of liquor on conductivity. Their equations vary quite considerably. In general, they express conductivity as a function of the nth root of the velocity of liquor. This value n is usually different for different types of condensers, and conse-

quently an equation cannot be taken without a thorough study of conditions under which this equation was established. Factors of which we have little knowledge may cause very great changes in conductivity with but slight changes in design.

IMPORTANCE OF FILM VELOCITY

For example, we may state with some assurance that the so-called film velocity of water has marked effect on conductivity realized. But what determines film velocity?
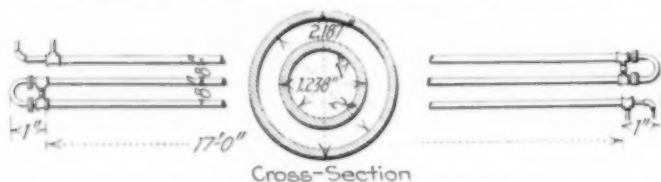
Tabulated experimental results indicate rather forci-

FIG. 1. VIEW AND CROSS-SECTION OF FLAT COIL COOLER

bly that a very slight change in design of heat interchanger may cause an almost unbelievable change in conductivity, and there appears to be no better explanation than that there has resulted a greater film velocity although the average velocity has not been altered. Marked differences in formulas established in the past and in our own work emphasize the necessity of more intense study and further experimental investigation.

SCOPE OF INVESTIGATION

As stated before, the work discussed in this paper concerns mainly the efficiency of so-called double pipe heat interchangers. We were interested in a system represented by a liquid-to-metal-to-liquid heat transfer. Inasmuch as the problem involved cooling acid liquors, a lead inner pipe was enclosed in a wrought iron jacket pipe. The procurement of maximum thermal conductivity was necessary in order to conserve lead pipe and to use a minimum amount of cooling water.

Although several designs of coolers were constructed for experimental data, this paper confines itself to a
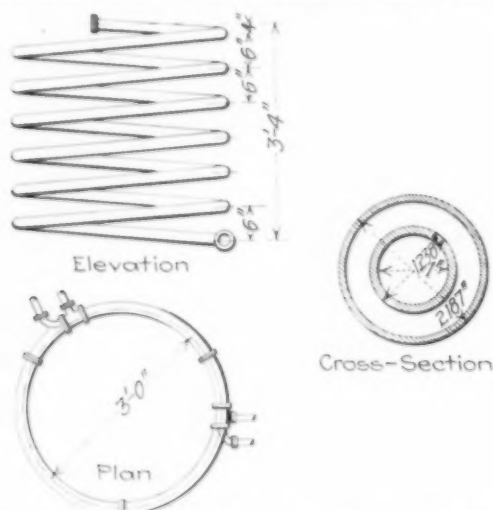

FIG. 2. VIEWS AND CROSS-SECTION OF SPIRAL COIL COOLER NO. 2

comparison of two types, the helical and the straight length. Sufficient data were accumulated to establish direct relationships, which may to a limited extent be used in considering other designs. It is to be noted, however, that although the factors which influence con-

ductivity in these tests may be used qualitatively for other types of coolers, no quantitative relationship should be assumed.

FINAL OBJECTS

Tests were carried out with three objects in view: first, to determine whether a double pipe coil put into the form of a helix would give higher conductivity than one with the same pipe dimensions put into 20-ft. lengths; second, to learn more regarding the effect of varying the diameters of the inner pipe of a helical cooler; third, to study the effect of changing the overall dimensions of a helical cooler.

APPARATUS USED

The units were set up as follows:

1. A 60-ft. 1-in. lead pipe within a 2-in. wrought iron pipe arranged in three 20-ft. lengths. The general assembly and a cross-section of the double pipe is shown in Fig. 1.

2. A 60-ft. 1-in. lead pipe within a 2-in. wrought iron pipe wound in the form of a helix and connected by flanges as illustrated in Fig. 2.
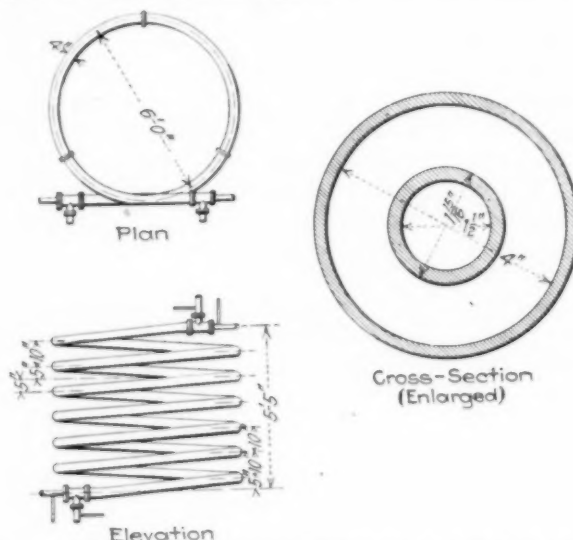
FIG. 3. VIEWS AND CROSS-SECTION OF SPIRAL COIL COOLER NO. 3

3. A 120-ft. 1½-in. lead pipe within a 4-in. wrought iron pipe flanged and wound in the form of a helix as shown in Fig. 3.

4. A 120-ft. 2-in. lead pipe within a 4-in. wrought iron pipe wound in the form of a helix in exactly the same way as represented by Fig. 3.

Each of these four coolers was set in place in very much the same way. The method for determining volume of liquor, temperatures, and velocities is shown diagrammatically by Fig. 4. Before each test, the hot liquor to be cooled was heated in a tank to the desired temperature by means of live steam. The volume delivered during the test was measured directly by drop of the level of the liquor in this tank. Cold water was pumped through the jacket and delivered over a weir for measurement. Pump pressures were regulated by means of a rheostat and thermometers installed at parts needed.

Usually a series of runs was made with different initial temperatures, in order to determine whether the temperature difference of hot and cold liquor materially influences the conductivity. During the test, readings were taken of the volumes and temperatures

of ingoing and outgoing liquor every 30 sec. The first readings were recorded after the system had been operating one full minute, in order to allow time for equilibrium to be established. Knowing the cross-section of lead pipe and wrought iron pipe, the velocities could be calculated.

VARIABLES STUDIED

The following factors influencing the conductivity in each case were studied:

1. Velocity of cold jacket water.
2. Velocity of hot water within lead pipe.
3. Change in conductivity due to a change in temperature.
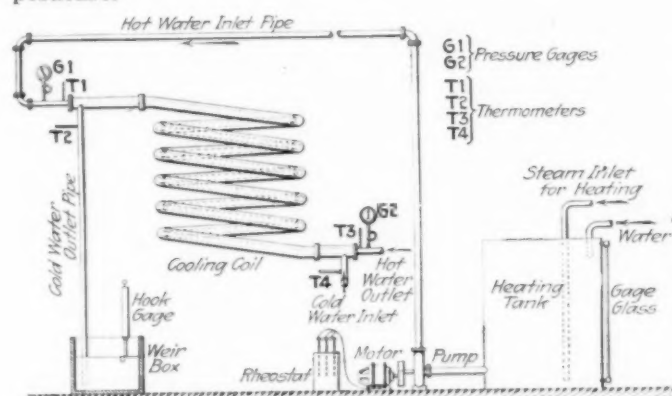
FIG. 4. DIAGRAM OF COOLING UNIT

4. Pressure of hot and cold water entering the system.

5. Change in conductivity due to change in design of cooler.

The tabulated results and data obtained in this way are shown by Charts I to VIII.

HELICAL VS. STRAIGHT LENGTH COOLER

Chart I illustrates the change in conductivity of No. 1 and No. 2 coolers with change of velocity of hot water, the cold water velocity being held practically

CHARTS I AND II. CHANGE IN CONDUCTIVITY WITH WATER VELOCITY

constant. Chart II pictures the change in conductivity taking place with different cold water velocities, keeping the hot water velocities practically constant. Inasmuch as there is no change in pipe dimensions, the differences in K represent the effect of curvature in the pipe.

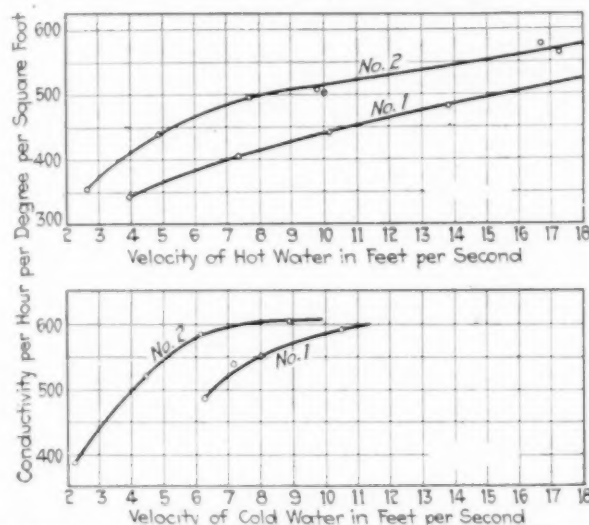Both charts show a substantial increase in K as the velocities of liquids are increased. This was to be expected. At corresponding velocities, the helical cooler gave in each case a higher K, indicating that the pipe curvature does increase the effectiveness of heat transfer. Chart II represents runs made with a rather high (17 ft. per sec.) velocity of hot water, and consequently the entire curve lies in a region higher than the curves shown in Chart I, which represents runs with a constant cold water velocity of only 6.1 ft. per sec. Moreover, the curves in Chart II are steeper, showing a greater mathematical change in K with change in cold water velocity.

Molier calculated from Joule's researches (*Z. Ver. deut. Ing.*, 1897, No. 6) that the conductivity of heat from liquid through copper to liquid could be represented by a formula (English units)

$$K = \frac{61.5}{\dfrac{1}{1 + 3.3V_h^{0.5}} + \dfrac{1}{1 + 3.3V_c^{0.5}}}$$

where V_h and V_c represent velocity of hot and cold liquids respectively. Such an equation means that either hot or cold water velocity increments have equal effects in changing conductivity obtained. This is probably true for some forms of coolers, but is dependent upon the design.

Equations were deduced from the experimental data
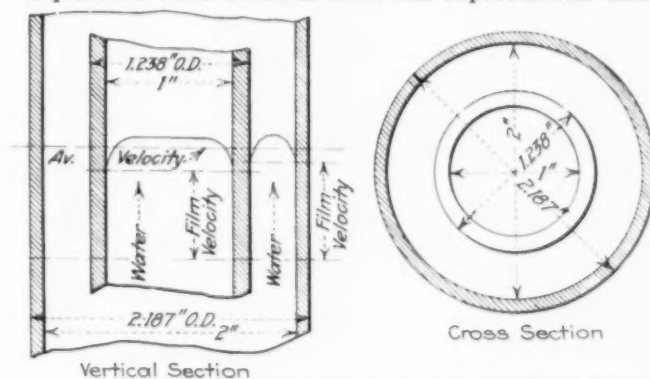
FIG. 5. FILM VELOCITY IN DOUBLE PIPE COOLER

on coolers 1 and 2 and are put into similar form as taken by Molier's equation.[1]

Cooler 1 (straight pipe).

$$K = \frac{62.7}{\dfrac{1}{1 + 5V_h^{0.57}} + \dfrac{1}{1 + 5V_c^{0.57}}} \quad (1)$$

Cooler 2 (small helix).

$$K = \frac{76.2}{\dfrac{1}{1 + 5V_h^{0.6}} + \dfrac{1}{1 + 10V_c^{0.5}}} \quad (2)$$

It is to be noted from these formulas that with each cooler an increase in cold water or jacket velocity can have a greater effect in increasing K than a corresponding increase in hot or inside water velocity. This may be due to a greater actual increase in film velocity of water in the jacket than that obtained by the same increase of average velocity of liquid within the inner coil, and this greater increment may be caused by the obstruction formed due to the position of the inner pipe. In order to get a clear mental picture of this explanation offered, it will be well to consider a sketch (Fig. 5) drawn to represent and distinguish average velocity and film velocity in the same pipe or tube.

[1]See Appendix for explanation.

The diagram shows a cross-section of a double pipe cooler, water flowing in the direction of the arrows. The average velocity in both jacket and in the coil is equal and represented by a.v. We have reason to believe that it is not this a.v. which determines the K of the system, but rather the film velocity, and this f.v. is evidently dependent upon the cross-section of channel as well as the a.v. of total liquid flowing through. Thus, we would state that the smaller the cross-section of the pipe or other channel, the higher will be the actual film velocity for a given a.v. As inferred above, quadrupling the a.v. may increase the film velocity of the inner coil by 2, whereas the same increase of average velocity in the jacket may raise the film velocity of
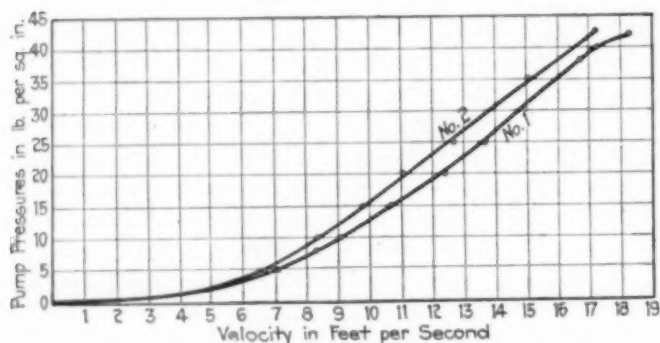
CHART III. VELOCITY IN INNER COILS WITH DIFFERENT PUMP PRESSURES

the jacket water by 2.5. We do not know whether K is *directly* proportional to film velocity. If it is, then by reversing the computations used, one could actually calculate the effect of increased a.v. on increased f.v., or solve the equation:

$$f.v. = f \ (a.v.)$$

In imagining the flow of water through a helical and through a straight cooler, it is not difficult to picture a higher f.v. for a given a.v. in the case of the helical cooler. The a.v. is calculated from actual gallons delivered and does not take into account the path of each particle of water as it travels through the cooler. The helical form would naturally add rotary as well as linear motion and result in greater total velocity of water film next to the surface. The data plotted confirm such a prediction. The conductivities obtained with the helical form of cooler averaged from 10 to 20 per cent higher than those obtained with the straight cooler.

The question of power arises. The rotary motion evidently causes more friction, and would necessitate a greater pump pressure to deliver a given capacity of water. Chart III shows the pump pressure plotted against average velocity with both coolers.

In the operating region of the chart the straight cooler shows a greater a.v. at a given pressure of about 1 ft. per sec. Referring back to Charts I and II, it will be noted that it would require a 4 to 5 ft. difference to compensate for difference in K found.

There are other analogies and differences which may be pointed out in reviewing the data from which these curves were drawn, only one of which will be considered here. For many years experimenters have made attempts to find relationships of K and temperature difference in a given system. The curves as plotted in Charts I and II were based on data which include at least four runs at each point, the initial water temperature ranging from 110 to 180 deg. F. A careful sur-
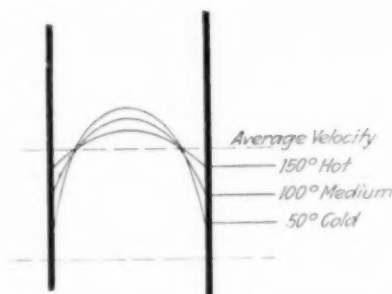
FIG. 6. TEMPERATURE EFFECT ON FILM VELOCITY

vey of the data[1] indicates that in general the K goes up very slightly with the initial temperature of hot H_2O. Inasmuch as the initial cold water temperature was held practically constant during any given series, an increase in initial hot water results in a greater average hot water and cold water temperature of both liquids passing through the apparatus. The only explanation we have to offer for a slight increase in K with higher average temperatures in the system depends on the fact that the viscosity of water decreases as the temperature is raised. It is probable that the film velocity for a given a.v. increases as the fluidity of the liquid increases, thus allowing greater conductivity. Graphically, we may represent in an exaggerated way the film velocity of water at three different temperatures. (Fig. 6.)

LARGE VS. SMALL INNER PIPES IN HELICAL COOLER

As outlined above, work carried out in the investigation allowed us to learn more concerning the effect on K of changing the diameter of the inner pipe and incidentally to speculate further on factors which influence film velocity. The units employed for the work were larger in size. Cooler 3 consisted of 120 ft. 1½-in.
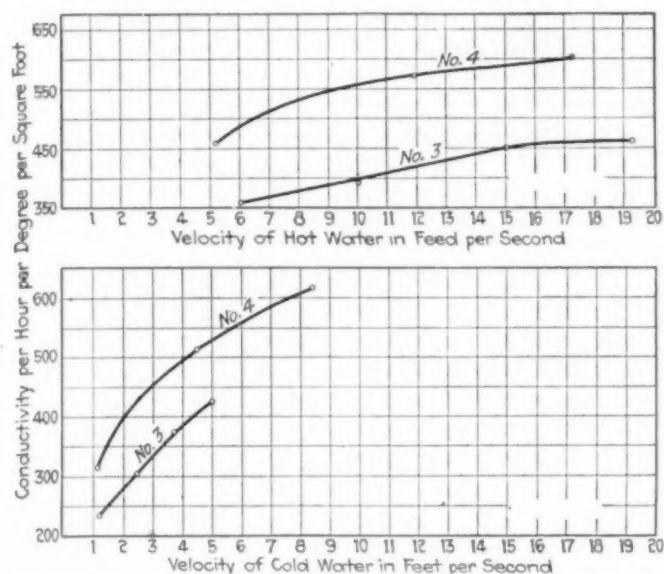
CHARTS IV AND V. RELATIONSHIPS OF WATER VELOCITIES AND CONDUCTIVITIES

lead pipe inside a 4-in. wrought iron pipe in the form of a helix 6 ft. in diameter. Cooler 4 substituted a 2-in. lead coil for the 1½-in. coil. Otherwise there was no difference. Similar series of runs were conducted as in the case of the smaller coolers. Charts IV and V show relationships of water velocities and conductivities.

These charts picture consistently the greater K obtained with the No. 4 cooler at average liquid velocities equal in each case. The magnitude of the differences rules out all chance of accident or inaccuracy. Our first hope was to explain this increase by some applica-

[1]Data were given in Appendix but are not included here.

tion of the film theory, and although subsequent work may confirm or reject our explanation, we will offer it for what it is worth.

It is reasonable to suppose that an increase in internal pipe diameter will, by contracting the jacket space, increase the ratio of $\frac{f.v.}{a.v.}$ in the jacket. Granting this, the greater will be the K, as far as determined by jacket velocity, as we increase the internal pipe diameter. Conversely, as the inner pipe diameter is increased, we should expect a lowering in ratio $\frac{f.v.}{a.v.}$ within the inner coil, which in turn would counteract
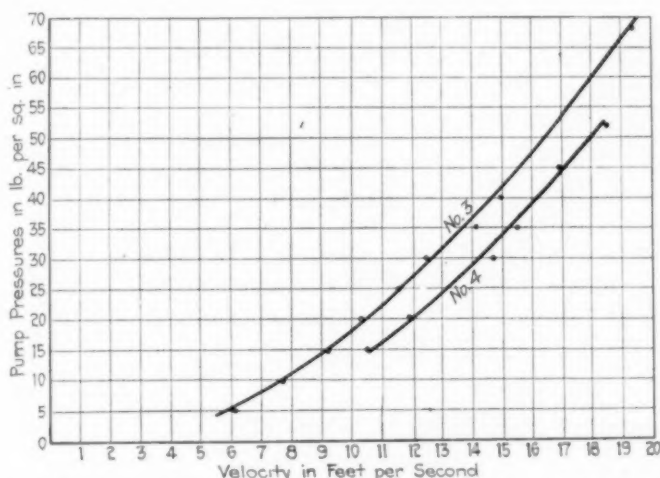
CHART VI.   VELOCITY IN INNER COILS AS AFFECTED BY PRESSURE

to a certain extent the jacket water ratio. Experimental results apparently prove that this compensating effect is only partial, which means that for a given increase in cross-sectional area of the inner coil, the f.v. increases much more in the jacket than the f.v. decreases in the inner coil.

Chart VI illustrates the changes in average velocity of hot water with change in pump pressure for both No. 3 and No. 4 units. Although no data are available to cover the point, it is reasonable to suppose that similar curves for jacket water velocities would be reversed.

The curves plotted on Charts IV and V may be represented by equations.

$$K \text{ (No. 3 cooler}^3) = \cfrac{57.5}{\cfrac{1}{1 + 5V_h^{0.57}} + \cfrac{2.60}{1 + 10V_c^{0.57}}} \quad (3)$$

$$K \text{ (No. 4 cooler)} = \cfrac{80.0}{\cfrac{1}{1 + 5V_h^{0.60}} + \cfrac{2.60}{1 + 10V_c^{0.50}}} \quad (4)$$

At zero velocity of hot and cold water, No. 3 cooler (by computation) has a conductivity of 15.95, whereas No. 4 cooler would show K equal to 22.2. It is of interest to note that Molier's equation for zero velocities gives a value $K = 30.75$.

SMALL VS. LARGE HELICAL HEAT INTERCHANGERS

In the above we have attempted to draw comparison between a straight pipe and helical cooler; also between helical coolers of different inner pipe diameters. It may be instructive to compare results obtained with the small No. 2 helical and large No. 3 and No. 4 helical units.

Charts VII and VIII show the characteristics of these three coolers grouped for comparison.

It is noted that No. 4 cooler gives highest K values, with No. 2 cooler ranking a close second. No. 3 unit is appreciably lower in K. The difference in pipe diameters as well as diameter of entire helix makes it difficult to theorize on similarities and differences.

We will, however, tabulate certain relationships which may throw some light on the subject. If $x =$ the distance from the inside surface of the jacket pipe to the center of the annular channel and $y =$ the inside radius of the inner coil, then for each of these coolers:

No. 2.........$\dfrac{x}{y} = 0.48$

No. 3.........$\dfrac{x}{y} = 0.687$

No. 4.........$\dfrac{x}{y} = 0.406$

Referring to Charts VII and VIII, we note that the conductivities increase inversely as the ratio listed. This appears to be in accordance with a theory advanced earlier in the paper; viz., that a narrowing in jacket area has greater effect in increasing film velocity than a corresponding enlargement of inner tube cross-section would have in decreasing the film velocity.

Equation 2 and equation 4 show the same close relationship as pictured by the curves covering No. 2 and No. 4 coolers.

SUMMARY

1. A double pipe heat interchanger in the form of a helix gives a marked increase in K over the same tubular parts put into the form of straight pipe lengths.

2. The film theory may account for this difference in K obtained.
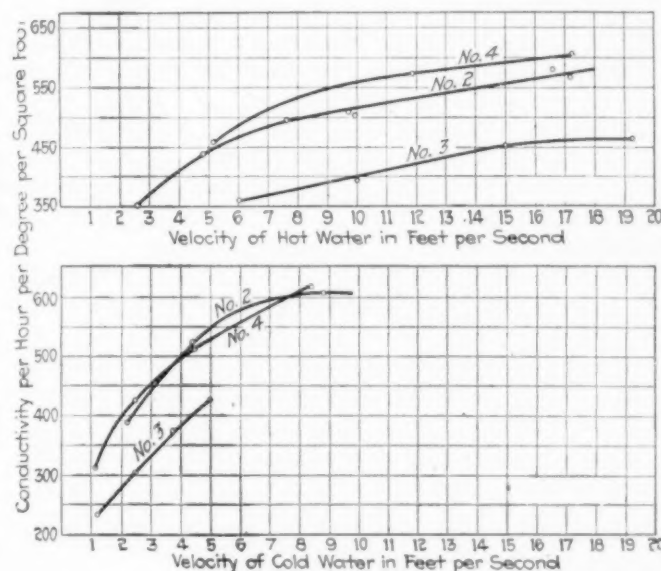
CHARTS VII AND VIII.   CHARACTERISTICS OF THREE TYPES OF COOLERS

3. The increase in pump pressure required with the helical unit is small in comparison with the added increase in thermal efficiency.

4. Conductivity in all cases apparently increases slightly with increase in average temperatures in the system. This may be due to an increase in ratio of $\frac{f.v.}{a.v.}$ as is explained in the contents above.

5. A helical cooler consisting of a 2-in. pipe within a 4-in. pipe gives higher conductivity than a correspond-

ing cooler equipped with a $1\frac{1}{2}$-in. inner coil. A reason is offered for discussion.

6. Conductivities in helical coolers appear to vary inversely as the ratio of distance from inside surface of jacket pipe to center of jacket channel, to the radius of inner coil.

The writer acknowledges with thanks the valuable assistance of Frank M. Jones, who carried on the actual experimental work.

Appendix

METHOD

Water was heated to the desired temperature in a large iron tank by means of live steam. A centrifugal pump, motor driven, circulated the hot water; the velocity being regulated by means of a rheostat. The amount of water pumped out of the tank was measured by means of the drop in a gage glass.

Cold water was obtained from the river and its velocity regulated by a valve. Its flow was measured by means of a weir and hook gage.

Temperature changes were observed through four thermometers directly immersed in the flowing liquids. Melted sulphur was used to seal these in the various apertures. The thermometers were placed as near the inlets and exits of the cooler as possible. Runs were made at temperatures approximating 110, 130, 150, 170 deg. Fahrenheit scale.

DATA ON APPARATUS USED

Tank—Height 5 ft. 6 in., diameter 4 ft. 7 in., capacity 677 gal. Water heated by live steam. Graduated water gage on side to measure outflow.

Pump—Lawrence, vortex $1\frac{1}{2}$ in. discharge, single side suction, gage 5 in. from discharge to measure pressure.

Motor—Westinghouse 5 hp. constant speed, 60 cycle, two phase, 440 volts.

Weir Box—Length 12 ft., width 1 ft. 4 in., depth 1 ft. $3\frac{1}{2}$ in.; contracted type, crest length 4.87 in., sharp crested. Channel of approach lined with tin, two vertical baffle plates serving to lessen surging.

Hook Gage—Of brass, reading to $\frac{1}{100}$ in.

Remarks—No. 1 straight cooler consisted of three 20-ft. lengths of 2-in. iron pipe containing 1-in. lead pipe. A surface of 36 in. of lead pipe (at the two ends) was exposed to the air and not affected by the cooling water. The under surface of the lead pipe was beaded at intervals to center it.

No. 2 helical cooler consisted of several sections of iron pipe bent to form a helical form. Three sections constituted one turn and were united by flanges. The overall dimensions were 36-in. diameter and 40 in. high. The lead coil was likewise beaded (or provided with lugs) at intervals to center it.

No. 3 helical cooler was similar to No. 2 except that 4-in. iron pipe was used for a jacket; three flanged sections to a turn; nineteen sections in all (or $6\frac{1}{3}$ turns). The inner lead pipe was not beaded (or "lugged") but merely laid loosely inside the jacket.

No. 4 helical cooler had the same jacket as No. 3 but contained a 2-in. instead of $1\frac{1}{2}$-in. lead pipe.

CALCULATIONS

Mean Temperature Difference.—The logarithmic mean was taken according to the formula (for counter-current).

$$T = \frac{(t_1 - t_4) - (t_2 - t_3)}{\log_e \frac{(t_1 - t_4)}{(t_2 - t_3)}}$$

where
T = mean T. diff.
t_1 = initial hot water temperature.
t_2 = final hot water temperature.
t_3 = initial cold water temperature.
t_4 = final cold water temperature.

CONDUCTIVITY

K, the conductivity constant, or B.t.u. extracted per hr. per deg. F. per sq.ft. of surface, is determined by:

$$K = \frac{A \times B}{T \times D}$$

Where
A = lb. of hot water flowing per hr.
B = drop in temperature of hot water $(t_1 - t_2)$.
T = mean temp. difference.
D = sq.ft. of cooling surface.

VELOCITY

$$V = \frac{\text{cu.ft. per sec. flowing}}{\text{cross-section of pipe (in sq.ft.)}}$$

WEIR

The weir flow was calculated from the well known Francis formula:

$$Q = 3.33(l - 0.2h)h^{1.5}$$

where
Q = discharge in cu.ft. per sec.
l = width of notch, in ft.
h = height of water above notch level, in ft.

EMPIRICAL EQUATION OF VELOCITY—K CURVE

Since the velocities of both hot and cold water are independently variable, the desired equation connecting K with water velocity will contain three variables. In the cases in which one velocity was held constant while the other was varied, and then *vice versa*, the relation of hot and cold water velocities to K can be studied separately. The simplest way to do this is to plot on logarithmic paper values of K against those of the variable velocity, which tests for a relation of the form $K = AV^b$, where A and b are constants, or indirectly also for the similar form $K = AV^b + C$, where C is also a constant. In the former case the graph approximates a straight line, in the latter a curve which is concave upward if C is positive, downward if C is negative. The experimental data give a graph which is a curve concave downward; this is an absurd result physically, since it means that at zero velocity K is negative. Another form of equation should be sought.

The form which is suggested by Hausbrand ("Evap. Cond., & Cooling App." Revised Ed., p. 305), namely,

$$K = \frac{1}{1 + 3.3V_h^{0.50}} + \frac{1}{1 + 3.3V_c^{0.50}} \text{(English units)}$$

has been found to satisfy the experimental data quite accurately, given slight changes in some of the numerical constants. An equation as this cannot be directly fitted to data, and a method of "cut and try" until the errors are below the experimental limit of accuracy is the only available method; on this account the constants are mainly round numbers, and the fit is not as close as might result from some method of direct solution.

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Political and Commercial Control of the Nitrogen Resources of the World—III

A Review of the Economic Nitrogen Industry Outlook: Chilean Nitrate, Nitrogen Fixation, Byproduct and Organic Nitrogen and Byproduct Ammonia—Bibliography of Recent Literature on the Nitrogen Industry*

By CHESTER G. GILBERT†

THERE is no import duty on nitrogen, nor is there likely to be any, for nitrogen is an important cog in the mechanism of food supply, and the peacetime emphasis, reversing the war-time order, is primarily on cheapness and only secondarily on the point of origin. Accordingly, looking ahead, the American market conditions, once world trade is fully restored, are due to reflect the world conditions. As indicated in Fig. 4,¹ the sudden ending of the war with its calling off of the military requirements which had been building up steadily since even before the outbreak of hostilities in 1914, left the world with a producing capacity 30 to 40 per cent above normal. To what extent this apparent overproduction, amounting to about half a million tons of nitrogen, will prove real is impossible to foretell; not all of it certainly, for under the stimulus of a food shortage the curve of normal consumption will doubtless bend upward. On the other hand, however, there is the producing capacity of the plants not yet in operation to be taken into consideration. Whatever may be the capacity of agriculture to absorb from the surplus, it cannot be expected to take up the full amount immediately or without special inducement. The inference follows that price and production will come down to stimulate and co-ordinate with the increase in demand. Where the meeting point will be between the upcurve of demand and the downcurve of production it is impossible to predict. It is of interest, however, to figure in review on how the three types of industrial source, the natural, the byproduct and the fixation types, are equipped for the evident strife of competition implied in the situation.

CHILEAN NITRATE AS COMPETITOR OF THE NITROGEN FIXATION INDUSTRY

With the development of fixation, there have been a lot of unfounded statements to the effect that the day of Chilean nitrate is passing. Whenever a synthetic development comes to the fore, a peculiar fallacy of reasoning is indulged in which ignores the fact of inherent natural worth, disregards the inescapable cost of its duplication, and regards the synthetic achievement as giving open sesame to the natural treasure. By way of substantiation in the case of nitrogen, the cost of producing Chilean nitrate is high, amounting to around $30 per ton. This, however, is largely contributed to by the unsystematized crudity of the operations, by the high export tax, and by over-

capitalization. But these, it will be observed, are variable factors, susceptible of indefinite modification in keeping with the need. Chilean nitrate has never made any pretence of competing against byproduct nitrogen with its advantages in the way of low incidental producing costs and proximity to the market. The discrepancy between the byproduct supply and the total demand for nitrogen has all along comprised the field of opportunity opening to Chilean nitrate. In this its only noteworthy competitor is the fixation industry.

VARIABLE FACTORS AFFECTING THE COST OF NITROGEN FIXATION

The fixation sources are impossible of analysis on a definite basis of cost. Too many variable factors and uncertainties are involved. Repeated attempts have been made, but all they have served to bring out is that under certain conditions, as for instance cheapness of power supply, and for certain purposes, one form of project has an apparent margin of advantage over another, and vice versa for other conditions, but that at best the cost of production, if not actually prohibitive, is dangerously close to the normal pre-war price of fixed nitrogen. Back of it all is the fact that fixation has to deal with the problem of overcoming the native chemical inertia of nitrogen, and the problem has not yet been solved at all convincingly. Always the solution advanced has called for some special measure of relief from industrial competition, whether natural as in the case of the Scandinavian power supply, or political as in the case of the American and German projects.

PROSPECTS FOR AN ECONOMICAL NITROGEN FIXATION INDUSTRY

Fixation has been widely heralded of recent years as due not only to emancipate the world from its dependence upon the Chilean source, but to reduce materially the cost of nitrogenous fertilizer, hence the cost of food production, to the marked betterment of living conditions as well. In its promise of political and economic betterment in one, it has claimed the attention of all. However, the claim of special economic advantage coming from an industry barely, if at all, able to meet conditions even as they are has been overdrawn. This does not aim to imply that there is nothing but failure ahead for fixation in the test of competition. It has its possibilities of development into something commercially and economically as well as politically worth while, but the existing hothouse order of upgrowth is unquestionably due for a lot of training down, and much that is worthless is as certainly due to go. The American developments have a particularly inauspicious economic setting in the prevailing scale of costs. The only saving alternative for them

would seem to be in one form or another of Federal provision for their continued support on some such basis as that on which they were projected, and this is unlikely, for there is no apparent reason. True, lowered nitrogen costs tend to make for a lowering in the cost of foodstuffs, but so, for that matter, would a lowering in the cost of agricultural implements, and any arguments that apply in the case of nitrogen apply as equally for potash, for phosphate, for agricultural implements, for coal; in fact, for industry in general.

OUTLOOK FOR THE BYPRODUCT NITROGEN DEVELOPMENT

With reference to byproduct nitrogen the situation is very different. In general, the byproduct sources are of an order such that they were not materially affected one way or the other by the war, and consequently are not due to be materially affected in the process of readjustment, except in the case of coke-oven ammonia, where the temporary slump in the steel industry will result in a temporary slump of probably 15 to 20 per cent from the 1918 output. Of special significance in connection with what lies on beyond for the byproduction of nitrogen is its relationship to the progress of industrial co-ordination. The whole current trend of industrialism as represented, integration, volume production, and the like, is actuated in the interests of co-ordination and the overcoming of lost motion; and nitrogen comes in for an important share in these developments.

OUTLOOK FOR ORGANIC NITROGEN DEVELOPMENT

With reference to the organic group of compounds, the outlook for the future is as uncertain as the actual conditions of today. The centralized development of meat-packing, of animal-rendering establishments, and of cotton ginning gave rise in their time to highly important recoveries of nitrogenous waste; but with the forward progress of developments this usage in turn is giving way to a more advanced order. Cottonseed as a fertilizer is giving place to a cottonseed products industry; tankage as a fertilizer is giving place to the artificial compounding of animal food; horses, an important contributor of agricultural nitrogen in times past, are yielding much of their place in the sun to the automotive engine. Meanwhile, with the factor of dilution to be overcome, our sewage disposal is employed to pollute streams and destroy the fish supply instead of being put to useful ends. So it goes. Developments are on foot that lead in both directions, and there is no telling how the balance is due to shift. Probably the best guess is that relatively at least it will be downward rather than upward.

OUTLOOK FOR BYPRODUCT AMMONIA

The outlook for byproduct ammonia is more definite. Ammonia is the end point of material refinement, so here the nitrogen developments hold all they get rather than going on to lose out again in a further refinement of usage, as in the case of the organic group. The output has increased consistently and rapidly, owing to the transition from beehive to byproduct coking operations, to the progress of centralization and co-ordination—in other words, with reference to coke manufacture. Even now, less than half of the coal coked is treated in the retort oven; but the beehive oven is out of the line of progress and is due to be entirely displaced. Also, the industry is still expanding as the process of transition with its separate

potentiality for doubling the present output of coal-product ammonia goes forward.

So far, the recovery of byproducts in connection with the use of coal has been confined in the one direction of coke making, along with the analogous procedure of gas manufacture. But the development which has thus started in the coke industry will not stop there. The loss of motion resulting from lack of co-ordination in the use of coal is just as great in other directions as in that of coke making, and the advantages of integral usage may confidently be expected to assert themselves. Already projects of the kind are coming under serious contemplation in proposals such as those for furnishing gas to cities, for employing byproduct operations located at the mine in support of the waning natural gas supply, and for integrated heat, light, and power projects operating on coal with byproduct recovery. Meanwhile, the motor-fuel situation is suggestive of interesting developments ahead. There is every reason to believe that the petroleum resources cannot continue to meet the growing demand, in fact, that the occasion for support is already at hand. Whatever the nature of these supporting developments, whether they take the form of a shale oil industry or what, it seems certain they will usher in an important source of byproduct nitrogen.

SUMMARY

Fig. 3 summarizes the American situation with reference to chemical nitrogen, as does Fig. 4 in less detail that for the world. Organic nitrogen is omitted, partly because of the lack of information, partly because the issues more directly involved in the situation as it stands are those of chemical nitrogen.

Bibliography

GENERAL

Mineral Resources of the United States. Issued annually by the United States Geological Survey.

The American Fertilizer Handbook. Published annually by Ware Brothers Co. of Philadelphia.

Statistical publications. The International Institute of Agriculture, Bureau of Statistics, Rome.

Roeber, *Mineral Industry*, vol. 19, pp. 58-67, 1910.

The Fertilizer Industry, U. S. Federal Trade Commission Report, 1916.

Gilbert, C. G. "Sources of Nitrogen Compounds in the United States." Publication 2421, Smithsonian Institution, 1916, 12 pp.

Martin and Barbour. "Industrial Nitrogen Compounds and Explosives." D. Appleton & Co., New York, 1916.

Brown, F. W. "Sources of Our Nitrogenous Fertilizers." United States Department of Agriculture Yearbook, 1917, pp. 139-146.

Hosmer, Helen R. "Literature of the Nitrogen Industries, 1912-1916." *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 424-438, 1917.

Nauchkoff, S. "How Do the Warring Nations Obtain Their Nitrogen Supply?" METALLURGICAL & CHEMICAL ENGINEERING, vol. 17, pp. 525-536, 1917.

"Work of the British Nitrogen Products Committee." METALLURGICAL & CHEMICAL ENGINEERING, vol. 18, pp. 77-81, 1918.

MINERAL NITRATES

Metodo de Esplotacion del Salitre Chileno por Medio de Palas a Vapor. *Bol.*, Soc. Nac. de Mineria, March-April, 1913.

Junghann, H. Die Saltpeterindustrie Chiles unter besonderer Berucksichtigung ihrer Wirtschaftslage. *Glückauf*, March 7, 1914.

Lamb, M. R. "Chilean Nitrate Industry." *Engineering and Mining Journal*, vol. 99, pp. 811-815, 1915.

Singewald, J. T., Jr., and Miller, B. L. "Genesis of the Chilean Nitrate Deposits." *Economic Geology*, vol. 11, pp. 103-114, 1916.

"Chilean Nitrate." *Pan American Magazine*, vol. 25, pp. 273-298, 1917.

Hobsbawn, I. Berkwood. "Nitrate Industry in Chile." METALLURGICAL & CHEMICAL ENGINEERING, vol. 16, pp. 253-259, 1917.

Rogers, A. H., and Van Wagenen, H. R. "Chilean Nitrate Industry." *Bulletin* of the American Institute of Mining Engineers, No. 134, pp. 505-522, 1918.

Irvin, D. F. "Chilean Nitrate Industry During 1918." *Engineering and Mining Journal*, vol. 107, pp. 265-267, 1919.

BYPRODUCT NITROGEN (ORGANIC)

Vageler, P. "Die Bindung des atmosphärischen Stickstoffs in Natur und Technik." Braunschweig, Vieweg, 1908, 132 pp.

Jodidi, S. L. "Chemistry of the Soil Nitrogen." *Journal* of the Franklin Institute, vol. 175, pp. 483-495, 1913.

Headden, W. P. "Excessive Quantities of Nitrates in Certain Colorado Soils." *Journal of Industrial and Engineering Chemistry*, vol. 6, pp. 587-590, 1914

Sullivan, M. X. "Nitrates in Colorado Soils." *Journal of Industrial and Engineering Chemistry*," vol. 6, pp. 532-533, 1914.

Sackett, W. G., and Isham, R. M. "Origin of the Niter Spots in Certain Western Soils." *Science* (new series), vol. 42, pp. 452-453, 1915.

Stadler, W. "Niter Spots." *Science* (new series), vol. 43, pp. 712-713, 1916.

Copeland, W. R. "Is the Recovery of the Nitrogen in Sewage Sludge Practicable?" *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 374-376, 1917.

O'Brien, W. J., and Lindemuth, John R. "The Fertilizer Value of City Waste. I. The Composition of Garbage." *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 49-54, 1917.

Schroeder, P. J. "The Fertilizer Value of City Waste. II. Garbage Tankage. Its Composition; the Availability of Its Nitrogen, and Its Use as a Fertilizer." *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 513-518, 1917.

Fred, E. B., and Davenport, A. "Influence of Reaction on Nitrogen-Assimilating Bacteria." *Journal of Agricultural Research*, Article 14, pp. 317-334, 1918. (Published by the United States Department of Agriculture.)

Genoud, Ernest G. "The Use of Micro-Organisms in Chemical Industry." CHEMICAL & METALLURGICAL ENGINEERING, vol. 19, pp. 616-617, 1918.

Hendrick, Ellwood. "Micro-Organisms in Plant Chemistry and Nitrogen Fixation." CHEMICAL & METALLURGICAL ENGINEERING, vol. 19, pp. 574-576, 1918.

BYPRODUCT NITROGEN (CHEMICAL)

Atwater, C. G. "Nitrogen and Nitrates From Bituminous Coal." *Gas Age*, vol. 38, pp. 403-405, 1916.

Childs, William H. American Iron and Steel Institute, May, 1916.

Koppers, H. Co., Pittsburgh, Pa. "Byproducts of the Coking of Coal in America." 1916.

Porter, H. C. "Coal and Coke Byproducts as a Source of Fixed Nitrogen." METALLURGICAL & CHEMICAL ENGINEERING, vol. 15, pp. 470-475, 1916.

Riley, L. A. "Byproduct Coal Ammonia as a Domestic Nitrate Source." METALLURGICAL & CHEMICAL ENGINEERING, vol. 15, pp. 112-113, 1916.

Atwater, C. G. "Sulphate of Ammonia: Its Source, Production, and Use." Issued by The Barrett Co., New York, 1917.

Woodward, Clarence R. "Recovering Ammonia at Tar-Distilling Plants." METALLURGICAL & CHEMICAL ENGINEERING, vol. 18, pp. 299-301, 1918.

FIXATION NITROGEN

Norton, Thomas H. "Utilization of Atmospheric Nitrogen." Department of Commerce and Labor, Bureau of Manufactures, Special Agents Series No. 52, pp. 1-178, 1912.

Tucker, S. A., and Read, H. L. "Fixation of Nitrogen by Alumina and Carbon." *Transactions* of the American Electrochemical Society, vol. 22, pp. 57-66, 1912.

Perlick, "Die Luftstickstoff Industrie in ihrer volkswirtschaftlichen Bedeutung." Leipzig, 1913.

Scott, E. K. "Manufacture of Nitrates From the Atmosphere." Annual Report of the Smithsonian Institution, 1913, pp. 359-384.

Baekeland, L. H. "Some Aspects of Industrial Chemistry." METALLURGICAL & CHEMICAL ENGINEERING, vol. 12, pp. 557-560, 1914.

Haber, Tamaru, Oeholm. *Z. Elektrochem.*, vol. 21, pp. 191-245, 1915.

Haber, Tamaru, Ponnaz. *Z. Elektrochem.*, vol. 21, pp. 89-106, 1915.

Landis, W. S. "Fixation of Atmospheric Nitrogen." *Journal of Industrial and Engineering Chemistry*, vol. 7, pp. 433-438, 1915.

Summers, Leland L. "Fixation of Atmospheric Nitrogen." *Transactions* of the American Electrochemical Society, vol. 27, pp. 339-383, 1915.

Washburn, Frank S. "The Cyanamide Process." *Transactions* of the American Electrochemical Society, vol. 27, pp. 385-407, 1915.

Addicks, L. "Conditions Affecting the Establishment of the Nitrate Industry in the United States." *Journal of Industrial and Engineering Chemistry*, vol. 8, pp. 1048-1050, 1916.

Nitrate Supply Committee Recommendations on Synthetic Nitric Acid for the Government, With Reports on Various Methods. *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 829-841, 1917.

Boyce, John C. "Bibliography of the Production of Synthetic Nitric Acid and Synthetic Ammonia. Part I, Literature; Part II, British, German, American, and French Patents. METALLURGICAL & CHEMICAL ENGINEERING, vol. 17, pp. 328-337, 1917.

Bucher, John E. "The Fixation of Nitrogen." *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 233-253, 1917.

Maxted, Edward B. "The Synthesis of Ammonia and the Oxidation of Ammonia to Nitric Acid." METALLURGICAL & CHEMICAL ENGINEERING, vol. 17, pp. 345-349, 1917.

Landis, W. S. "The War and the Nitrogen Industry." CHEMICAL & METALLURGICAL ENGINEERING, vol. 19, pp. 828-830, 1918.

Scott, E. Kilburn. "Direct and Indirect Methods of Nitrogen Fixation." CHEMICAL & METALLURGICAL ENGINEERING, vol. 19, pp. 411-414, 1918.

Scott, E. Kilburn. "Nitrogen Fixation Furnaces—I." CHEMICAL & METALLURGICAL ENGINEERING, vol. 19, pp. 710-715, 1918.

Scott, E. Kilburn. "Nitrogen Fixation Furnaces—II." CHEMICAL & METALLURGICAL ENGINEERING, vol. 19, pp. 757-761, 1918.

Fairlie, Andrew M. "Muscle Shoals Nitrate Plant." CHEMICAL & METALLURGICAL ENGINEERING, vol. 20, pp. 8-17, 1919.

Hollister, H. E. and C. E. "Erection of Huge Sulphuric, Nitric, Mixed Acid, and Denitrating Plant Under War Pressure." CHEMICAL & METALLURGICAL ENGINEERING, vol. 20, pp. 406-412, 1919.

Landis, W. S. "The Oxidation of Ammonia." CHEMICAL & METALLURGICAL ENGINEERING, vol. 20, pp. 470-477, 1919.

Parsons, Charles L. "The Oxidation of Ammonia." CHEMICAL & METALLURGICAL ENGINEERING, vol. 20, pp. 502-503, 1919.

White, Alfred H. "The Present Status of Nitrogen Fixation." *Journal of Industrial and Engineering Chemistry*, vol. 11, pp. 231-237, 1919.

Polish Salt Resources and Production

Rock salt is one of the most important natural resources of the new State of Poland. The production of salt in Polish territories just prior to the war was approximately as follows: Former Austrian Poland (Galicia), 141,215 metric tons; former German Poland (Poznania), 81,269 tons; former Russian Poland, 3,007 tons; total, 225,491 tons.

There is no doubt that these Polish salt deposits are capable of much more intense exploitation and, under proper organization, they could probably become the base for several branches of the chemical industry. This is one of the Polish industries wherein American capital would probably be welcomed at the present time.

Galicia also possesses at Kalusz the only potassium salt mines, besides those at Stassfurt, Germany, and a company has recently been formed to exploit this deposit. These Kalusz salts are composed chiefly of kainite and sylvite. The production of kainite, which amounted in 1893 to 4,000 tons, had risen in 1913 to about 17,500 tons, valued at $47,000. This deposit also was worked before the war by the Austrian Government, and it is hoped that now, under private initiative, it will become a considerably greater source of revenue.

American Beet Sugar Industry

IN ADDRESSING the Detroit Engineering Society on Jan. 23, Martin J. Kermer, chief engineer of the Cannon-Swenson Co., Chicago, spoke at length on processes employed in refining and economic features surrounding the sugar industry at present.

The total world production of sugar for 1919, expressed in terms of refined, is approximately 16,500,000 tons of 2,000 lb. each. Of this, the United States produced 915,000 tons, of which 795,000 tons were beet and 120,000 tons were made from cane. In other words, the United States produced approximately 5½ per cent of the world's supply. In regard to our consumption, we used last year approximately 4,000,000 tons, or 22,200,000 lb. per day, or 76 lb. per capita per annum. We are, therefore, consuming one-fourth of the world's production. We are producing approximately 23 per cent of what we consume. Another 24 per cent comes from Hawaii, Porto Rico and the Virgin Islands; while the remainder, over 53 per cent, comes from the Philippine Islands, Cuba, and foreign countries.

CONSUMPTION PER CAPITA

It is interesting to note that from 1865 up to 1914 our consumption of sugar per capita per annum has gradually increased from 18 to 89 lb. Ever since the war started this consumption has been reduced year by year due to the shortage of production, which necessitated our restrictions. Today the world's production is 2,800,000 tons less than it was in 1914. If we consider the annual increase of consumption per capita for this country from 1900 to 1914, it is safe to say that we would have reached 100 lb. per capita per annum if conditions were normal.

In the period 1904-13 the average yearly consumption per person in countries named was as shown in Table I.

TABLE I. PER CAPITA CONSUMPTION OF SUGAR

	Lb.		Lb.
Australia	113	Belgium	26
United Kingdom	85	Russia	14
Germany	30	United States	78
France	28		

COMPARATIVE PRODUCTION

Previous to the war the United States ranked fourth in beet sugar production, today second. This is due to decreased production in Europe, as shown by Tables II and III.

TABLE II. BEET SUGAR PRODUCTION IN THE UNITED STATES

	Tons		Tons
1913-1914	726,000	1917-1918	766,000
1914-1915	724,000	1918-1919	762,000
1915-1916	872,000	1919-1920	795,000
1916-1917	824,000		

TABLE III. COMPARATIVE PRODUCTION OF BEET SUGAR

	1913-14 Tons	1919-20 Tons
Germany	2,920,000	800,000
France	877,000	165,000
Austria	1,870,000	16,000
Czechoslovakia		700,000
Poland		300,000
Russia	1,918,000	None
Belgium	252,000	112,000
United States	726,000	795,000

In 1913-14 Europe produced 9,827,000 tons, and 3,503,000 in 1919-20, a decrease of over 6,300,000 tons.

Before the war, Europe had about 1,250 beet sugar factories in operation, and the European countries have realized for a long time the importance of the beet sugar industry. These governments were justified in encouraging the sugar industry, as it not only meant the development of the industry proper, but also its allied industries.

PRODUCTION SHOULD BE INCREASED AT HOME

The United States has ninety-nine factories in operation, which should be increased to 500 factories to satisfy domestic consumption. Comparing with Europe, the area is about three-quarters the total. If our beet sugar industry were developed in proportion to areas, the United States would have 930 factories in operation, or ten times the present number.

About $420,000,000 is spent abroad for importing sugar to this country each year. The distribution of this sum at home means something when analyzed.

If we say that our sugar consumption is 4,000,000 tons per year, that 23 per cent is produced in the United States proper, 24 per cent from Hawaii and Porto Rico; then the remainder, 53 per cent, or 2,100,000 tons, has to be imported. If we figure this at 10c. per lb., it means that we are sending to foreign countries $420,000,000.

The mere fact that we are sending over $400,000,000 out of the country for a product which we could produce ourselves does not signify so much until we begin to analyze how this money would have been distributed among our own people had we produced this sugar ourselves.

Supposing this sugar was made from beets, containing, say, 15 per cent sugar, at twelve tons of beets per acre, while the factory would have an extraction of 83 per cent. Then for every ton of sugar we require eight tons of beets, or a total of 16,800,000 tons of beets produced on 1,400,000 acres of land. This would mean that the sugar companies would pay the farmers $168,000,000 for beets; the farmer pay his laborers for preparing the soil, planting, cultivating and harvesting his crop, $90,000,000; while the farmer would have about 4,000,000 tons of beet tops left on his land after the crop was removed, which represents valuable cattle feed after it has been properly siloed. This would feed and fatten some 2,000,000 steers for 120 days.

The factories would be paying, during a campaign of approximately 100 days, $20,000,000 for labor in the factory for producing sugar from beets, $13,000,000 for coal, $20,000,000 to the railroad company, and $47,700,000 for miscellaneous items such as coke, lime rock, bags, maintenance and repairs.

If these factories would have pulp drying plants such as all modern factories have, they would produce 840,000 tons of dried pulp, which is also valuable cattle feed and would represent a value of approximately $27,000,000. In order to produce this 840,000 tons of dried pulp, the sugar company would spend in the neighborhood of $3,000,000 worth for labor. Approximately $113,000,000 is paid out for direct labor. If we consider the turnover of this amount alone, we get figures that would astonish us.

It is the money set in circulation by the sugar companies and farmers for labor and materials that pay for harbors, highways, schools and churches, and support our universities, and make it possible to further develop our lands, railroads and allied industries.

La Belle Coke Plant

By G. P. Blackiston

BEING the first Koppers byproduct coke plant in the Pittsburgh district, excluding Youngstown, and the only modern plant of its kind in the Ohio Valley, is the distinction which belongs to the new ninety-four oven Koppers plant of the La Belle Iron Works, located on the south bank of the Ohio River, opposite the company's main plant at Steubenville, Ohio.

The new plant, which has two batteries, each of forty-seven standard Koppers 12½-ton ovens, and is planned to permit duplication, replaces beehive ovens formerly operated by the company at La Belle, Pa.

LOCATION OF THE PLANT

It was the original plan of the owners to build the plant on the Ohio side of the river, adjacent to the Steubenville mill and furnaces, but the West Virginia site was decided upon when it was found impossible to secure enough land contiguous to the present plant to allow room for future expansion. The choice of the West Virginia site added considerably to the cost of the plant. A great amount of extra foundation work was necessitated, and a fill of 15 to 20 ft. over the entire site was required to bring the plant to an elevation above the flood stage of the river. The ovens themselves were carried 8 ft. above the new level

GENERAL VIEW OF BYPRODUCT PLANT, SHOWING LOADED COAL BARGES IN HARBOR, COAL UNLOADING DOCK, COAL HANDLING AND PREPARING PLANT. OVENS AND BYPRODUCT BUILDINGS

Bridge Co., and is the first cantilever bridge ever erected without a traveler or creeper, a crane with 110-ft. boom being used in its erection throughout. The supporting piers are of reinforced concrete 120 ft. high, which were sunk to bedrock, a distance of 43 ft. below pool level, the caisson method being employed.

COAL SUPPLY AND TRANSPORTATION

A unique feature of the new plant is the coal-handling system. The coal used, excepting a small percentage which is mined in the nearby West Virginia fields and brought to the plant by railroad, is transported over the Monongahela and Ohio Rivers from the Pennsylvania coal district. For this purpose barges having a capacity of 350 to 600 tons are used, the barges being towed down the river in fleets of six to ten. Harbor facilities are provided where approximately thirty loaded barges may be tied up awaiting their turn at the unloading dock, while the same number of empties can also be accommodated. A truck hopper handles the coal shipped in by rail and a storage yard of 100,000-ton capacity is provided to insure an adequate supply for use during the winter months when the river may be closed to navigation.

UNLOADING COAL BARGES

Coal is unloaded from the barges by two Heyland & Patterson traveling gantry cranes, with 100-ft. bridge. These cranes are each mounted on four two-wheeled trucks and travel over a 20-ft. gage track,

BRIDGE CONNECTING COKE PLANT WITH THE STEUBENVILLE WORKS

in order to bring the stack flues above the flood stage. An excess of 900 yd. of filling material was placed on the site and more than 70,000 yd. of concrete was used in the construction of foundation. Void wall construction was used in the oven foundation, which extends to a depth of 28 ft. below the oven mat, the voids being filled with granulated slag. Piers and curtain walls were used in the foundations of all the buildings and the floors were laid on a granulated slag fill. All underground conduits were laid before the fill was made, being erected on concrete piers.

CONNECTION BETWEEN THE LA BELLE, PA., AND STEUBENVILLE, OHIO, PLANTS

To provide traffic communication between the two plants and insure an uninterrupted supply of fuel for the furnaces, it was necessary for the company to erect and maintain its own bridge across the river. This structure, which is of the cantilever type, is 1,520 ft. in over-all length, and consists of four 100-ft. girder spans, two 30-ft. anchor spans, and a main channel span 660 ft. long. It was planned and built by the American

COKE SIDE OF OVENS AND COAL GALLERIES
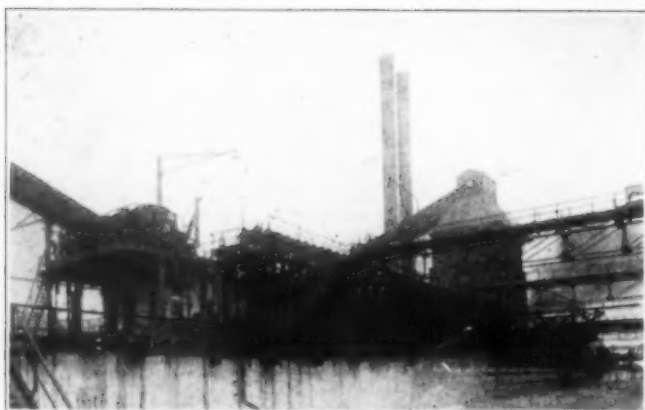
PUSHER SIDE OF OVENS, SHOWING COMBINED COKE
PUSHER AND LEVELING MACHINE

so that they may also be used to handle coal in the
stock yard. They are equipped with 3½-ton buckets, and
have a hoisting speed of 500 ft. per min. The buckets
are specially designed with a view to clean unloading
in minimum time with minimum labor.

When unloading, the crane remains stationary on the
dock, the barge being moved along the dock by an
electrically operated barge shifter. Under normal con-
ditions the coal is dropped into a small hopper located
on the dock. It is then fed through the bottom of
this hopper into a 30-in. conveyor belt, which in turn
discharges it into the track hopper. If it is desired
to stock the coal from the river, empty cars are placed
over the track hopper and the coal is discharged from
the conveyor into them.

COAL STORAGE

Loaded cars are moved by means of a cable haul to
one of the several unloading pits which are located
every 125 ft. along the entire length of the storage
yard. From these pits the coal is transferred to the stor-
age pile by one of the gantry cranes. When it is desired
to use coal from stock this operation is reversed, the
crane loading the cars, which are then transferred to
the track hopper and unloaded.

The unloading dock, which is 100 ft. long and has
a 100-ft. fender at each end, was built by the National
Contracting Co., of Cleveland, Ohio, while the coal-
handling system and storage-yard system was designed
and built by the Heyland & Patterson Co., of Pitts-
burgh, Pa.

From the track hopper, coal is carried by a short
length pan conveyor to a 36-in. conveyor belt, which,

COKE WHARF AND SCREEN STATION IN BACKGROUND

driven by two 50-hp. G. E. motors, travels on a 20-deg.
incline to the top of the breaker building, where it
delivers the coal to the Bradford breaker. From the
breaker which removes the slate and sulphur, the coal,
having been reduced to 1½-in. lumps, is carried by a
conveyor belt and discharged into the proper one of
three mixing bins. From the mixing bins it is fed
by gravity into the regulator by adjustable gates, so
that any desired percentage of each grade of coal can
be secured. The three mixer belts discharge into the
same chute, which leads to the hammer mills, where
the coal is pulverized to a fineness of 85 per cent
through a ⅛-in. screen. It is then elevated by conveyor
belts to the 1,800-ton storage bin located above the
charging floor and between the two batteries of ovens.
Rovins-Conveyor Belt Systems are employed throughout.

ELECTRIC HANDLING EQUIPMENT

The chutes on either side of the hammer mills are
equipped with rotary feeders, which insure an even
and constant feed and eliminate about 90 per cent of
the dust which is so common about coal-handling plants.

BENZOL BUILDING, SHOWING WASH OIL COOLERS,
CIRCULATING TANKS AND OVENS IN
THE BACKGROUND

All the coal-handling equipment is individually motored
and the control is interlocked in such a way that no
conveyor belt or crusher can be started or operated
until the machine next in progression is in operation;
in this way spillage or piling up of the coal, if one
machine should stop while the operator or attendant
is not present, is eliminated; three-phase, 220-volt,
alternating current is used throughout the coal-handling
plant, which is equipped with General Electric motors
throughout.

All the control boards for the various motors are
housed in the control building, which is located at a
sufficient distance from the main plant that the delicate
electrical control instruments may not be injured or
incapacitated by coal dust; a push button located near
each motor enables the operator to stop and start the
machine at will.

COKE OVENS

The pulverized coal from the storage bin is fed by
gravity into one of the two (Morgan) charging
machines. The ovens are of the standard Koppers
30-flue type, and the heating system is so arranged
that gas is burned in the fifteen flues at one end of
the furnace and the heated air and products of com-
bustion pass out through the remaining fifteen flues
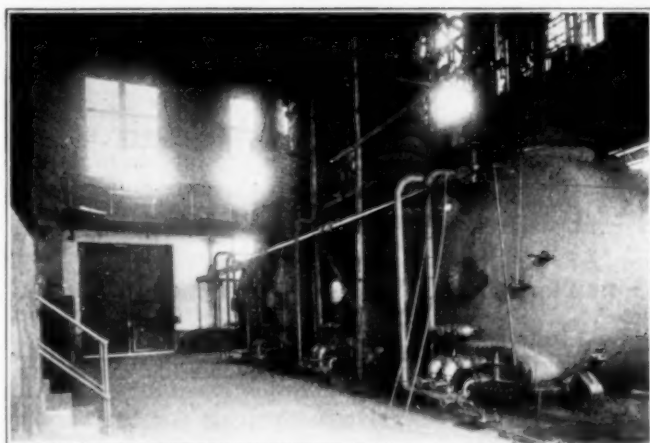
INTERIOR OF BENZOL BUILDING, SHOWING CRUDE
AND PURE STILLS

to the flue stack, giving off heat as it goes. This arrangement is reversed every 30 min., insuring a continuous even heat at all times. This change is made automatically, the gas valves, stack dampers and draft dampers being controlled from the control house, which is situated between the two batteries of ovens. The entire operating mechanism is governed by an electric clock, no attendant being required. The machines which operate these valves and dampers are electrically driven, but a steam engine is provided for use in an emergency.

In the central building are also located a venturi gas meter for recording the gas consumed, and other devices for indicating the temperature, gas production, etc.

COKE HANDLING

The discharging, quenching and handling machinery is all standard Koppers equipment. The coke, after quenching and cooling, is dumped into a wide chute, from which it is fed through gates into a conveyor belt, on which it is carried to the grader, where it is graded into various sizes. Some is transported across the river to the furnaces, some sold for commercial consumption and the breeze used in the power plant.

BYPRODUCTS PLANT

The byproduct gas given off at about 1,000 deg. C. is collected in a 16-in. main, through which it is drawn by two Connersville Stove Blower Co.'s steam-driven gas blowers at 128 cu.ft. displacement, driven by a 250-hp. Harrisburg Foundry & Machine Co. compound engine, and forced through water-tube coolers, where it is cooled to about 28 deg. C. The sudden cooling condenses the tar vapors; the tar is run off into a settling reservoir. Here the gas liquors which are contained in the condenser, being lighter than the tar itself, rise to the top and are drained off. The tar in this state is pumped to the nearby plant of the American Tar Product Co.

The gas, relieved of its tar contents, passes into the reheater, where it is brought to a temperature of 60 deg. C. and forced into the saturator, and the ammonia is removed as ammonium sulphate.

The byproducts plant is equipped with four water-tube coolers, tar extractor, reheater, saturator ammonia stills and draining tables and centrifugal driers for the ammonium sulphate, for which a 2,500-ton storage room is provided, three benzol scrubbers, two continuous condensing stills for benzol vapor, agitators,

fractional condensing stills where the light oil is fractionated into crude benzol, crude toluol, crude light solvent naphtha, crude heavy solvent naphtha, agitators and four 8,000-gal. purification stills where the pure products are produced and two final coolers for the gas.

PUMPING EQUIPMENT

Three Gould 20,000-gal. circulating pumps are employed to keep the water in circulation through the water tube coolers. A tar-loading pump of 10,000-gal. capacity and two 6,000-gal. hot drawing pumps are provided, together with two 6,000-gal. ammonia pumps. driven by 150-hp. Westinghouse motors for circulating the ammonia liquor through the stills. Six Gould wash oil circulating pumps with a capacity of 15,000 gal. per min. against a 180-ft. head are employed in connection with the benzol scrubbers. There are also two 150-hp. Westinghouse motor Gould single-stage circulating pumps with a capacity of 3,000 gal. per min.

The other pumping equipment, in addition to two air compressors which furnish compressed air for general use, includes a 250-hp. Westinghouse motor-driven gas pump which pumps the surplus gas through a 16-in. main over the bridge to the Steubenville furnace, and a 200-hp. Westinghouse motor-driven Ingersoll-Rand type 10 Imperial gas pump.

All pumping machinery is electric motor driven, but has emergency steam drive.

POWER PLANT

The power plant, which forms a separate unit, consists of four 400-hp. Stirling water tube boilers which are fed by two Epping Carpenter 12 x 7 x 12 boiler feed pumps. The boiler water is heated in a Cochrane feed water heater.

The boilers are equipped to burn either gas or coke breeze, but the coke breeze is generally used, being burned on a Cox chain grate with forced draft.

Electric current is supplied by the West Pennsylvania Power Co. from its Beech Bottom, W. Va., plant, being received at the plant at 22,000 volts, 60 cycle, three phase, but is stepped down to 2,200 and finally to 220 by a series of Westinghouse transformers.

Two G. E. motor generators, Type M. P. C. 6,500-200 Form L 200 amp., are used to furnish the direct current required in the plant.

Other notable features of the plant include a model laboratory, one office building, coal test building, and service building which is equipped with individual chain hangers for the clothes of the employees, showers, toilet accommodation, etc.

BOILER HOUSE, POWER STATION, TIME OFFICE, GENERAL
OFFICE AND TAR STORAGE TANKS

Legal Notes

By WELLINGTON GUSTIN

Mutual Releases in Settlement of Claims No Bar to Recovery of Metals

From the Supreme Court of New York comes a case arising out of cancellation of war contracts. The parties had made a settlement of a claim for damages on account of a breach of contract. The plaintiff claimed that the terms of settlement required the return to it of certain metals, which the defendant refused to deliver on the ground that a general release delivered to him along with plaintiff's check for $8,500 "in full settlement" concluded the entire transaction. (R. A. Union Metallic Cartridge Co. vs. Atkinson, 177 N. Y., 723.)

It appears that plaintiff had taken a contract from the French Government and part of the order was re-contracted for with the defendant. The French Government cancelled its contract with the plaintiff, which in turn cancelled its own contract with the defendant after part of the supplies had been made and delivered to plaintiff. Defendant thereupon presented his bill for damages, in three items: First, prospective profit; second, metals on hand; third, depreciation on other metals used by defendant outside the contract. Controversy arose over the claim for prospective profits. Plaintiff offered to settle this if it be reduced one-half. Reaching no agreement, suit was instituted by the defendant. During progress of this suit terms of settlement were discussed. Finally defendant's counsel offered to throw off $1,000 from the profits item, and the plaintiff's counsel replied, offering to pay $8,500 in full settlement.

The court here said that had the defendant's acceptance of this offer been unqualified, there was no doubt that he would have been obligated to return the metals, for their delivery was unquestionably contemplated in all previous negotiations. But instead of an unqualified acceptance of plaintiff's offer, defendant's counsel added, "if mutual general releases can be exchanged at the same time." This modification was accepted, the $8,500 paid and the general releases exchanged. When a few days later plaintiff asked for the return of the metals, defendant's attorney ruled that the release of the defendant given by plaintiff barred its claim. Then this suit was started by the plaintiff to recover the value of the metals.

That the offer of $8,500 was conditional upon the return of the metals—an item of $3,927.09 in the invoice claiming the damages—is unquestionable, said the court. In the light of the invoice as presented and of the protracted controversy concerning its principal items of prospective profits, throughout all of which the return of the unused metals to the plaintiff was an understood condition, to be performed as soon as the amount of the invoice should be agreed upon and paid, what is the reasonable construction to be placed on the acceptance of the offer of $8,500 in full settlement "if mutual general releases can be exchanged at the same time" became the point to be determined by the court. Did the additional clause have the same force and effect as if it had read, "Your offer is accepted on condition that the metals are not to be returned"? That is impliedly the stand taken by the defendant. But the court thought otherwise. "I think not," said the court, "whether the question is viewed as one either of fact or of law."

"There is no such magic in the condition that releases be exchanged as can obliterate all that had gone before. . . . The obligation to return the metals grew out of that transaction, was a part of it, and the release from the plaintiff to the defendant did not bar it. It was, indeed, a part of the consideration for the release."

Plaintiff, being held entitled to the metals in defendant's hands, was held entitled to their market value on the date of the demand for their delivery, with interest.

Compliance With Statute Requiring License for Sale of Fertilizer

In an action of assumpsit to recover on a note given for the price of fertilizer sold to defendant, he defended on the ground of illegal consideration for the note, in that it was given in payment of fertilizer to parties who, at the time of sale, did not have a state license authorizing them to make a sale as required by law. These parties testified they were a partnership having a contract with the Dothan Chemical Co., otherwise known as the Alabama Chemical Co., both companies being one and the same and under the same management. Under the contract the fertilizer was shipped on consignment to the partnership as trustee for the company, the property remaining in the company until sold and paid for, and when sold all proceeds, including cash, notes, open accounts, mortgages, securities therefor, etc., were to be kept separate and held by the partnership as trustee for the company, and turned over as collateral security and pledge against the notes of the partnership until their indebtedness under the contract of sale was paid in full. (Bowdoin vs. Alabama Chemical Co., 79 So., 4.)

The two questions presented for decision were: First, whether a contract of sale of commercial fertilizer made without the seller's first having taken out a license as required by the statute is void; and second, if it be void, did the sales contract in this case between the partnership and the Dothan Chemical Co. create the relation of principal and agent as regards the sale of the fertilizer in question?

Said the Alabama Supreme Court: The rule in this state is that, if a statute was not designed to prohibit the making of contracts without previous compliance with statutory provisions, but was intended merely to provide revenue, it is not void if no specific prohibition or penalty is provided or imposed. If the conditions of the statute were made for the benefit of the public, and not for the purpose of raising revenue only, an agreement is void that does not comply with the statutory conditions.

In the adoption of the statutes in question the legislative intent and primary purpose was to protect the public against being sold worthless or deleterious compounds represented as commercial fertilizers, and not merely to raise revenue, so held the court.

Referring to the second question, the court held that the contract and testimony of the partner showed the partnership was selling as agent of the chemical company, and therefore the statutes were complied with on proof that the chemical company was issued a fertilizer license by the Commissioner of Agriculture covering the period for which the sales were claimed illegally made. The contract between the partnership and the chemical company being interpreted as one of agency instead of sale, the sale to defendant for which the note was given was held to be valid, having been made under the license held by the chemical company.
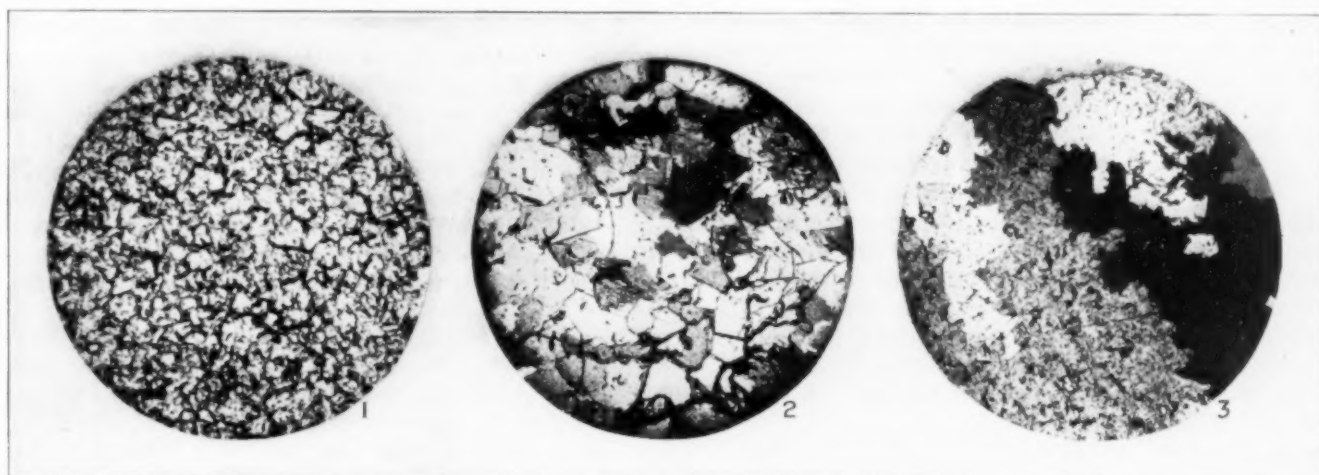
A New Aluminous Abrasive

By Otis Hutchins

FOR some time the mechanical industry has needed an abrasive which could be bonded into a wheel having extraordinary sharpness, fast, cool-cutting ability, uniformity and long life—a wheel that would not only have these qualities but at the same time would be what might be termed open and "brittle" so far as its structure was concerned. Such a combination of virtues was extremely necessary in the wheels that are principally used in the grinding of high-speed and case-hardened steel and for surface grinding.

After a period of research the Carborundum Co. has perfected a new abrasive material having such characteristics. This new abrasive material is to be known as Aloxite "AA," and is now being made in quantity.

The bulk of the aluminous abrasive now used in grinding operations contains from 92 to 96 per cent alumina, $2\frac{1}{2}$ to 4 per cent titanium oxide, $\frac{1}{2}$ to 1 per cent each of

ing a length of 12 mm. (0.5 in.) or more. Impurities are present to about 1.5 per cent or very much less than in the ordinary type of aluminous abrasive. This decreased amount of impurity has an important bearing on the characteristics of the abrasive grain and the wheel made from it. Its cutting power is increased due to the greater amount of crystallized alumina present. There is less fluxing between the bond and the grain, this resulting in the brittle wheel so necessary for rapid cutting. It also makes possible, due to the high purity of the grain, to produce wheels of very soft grade. The small amount of impurities allowed to remain in the abrasive is not objectionable, but on the other hand is extremely beneficial. It prevents the formation of skeletal crystals and prevents the more or less open and porous structure which is obtained when molten pure alumina is allowed to solidify. The resulting abrasive consequently exhibits a greater toughness and the wheel has a longer life.

The large size of the alumina crystals in Aloxite

FIGS. 1 TO 3

Fig. 1—Ordinary aluminous abrasive; 94 per cent Al_2O_3; $\times$ 8. Fig. 2—High-grade aluminous abrasive; 96 per cent Al_2O_3; in polarized light; $\times$ 8. Fig. 3—Aloxite "AA," by polarized light; 98 per cent Al_2O_3; $\times$ 8.

iron oxide and silica and lesser amounts of lime and magnesia. Most of the alumina is present in the crystallized state, while the other impurities combined with a small portion of the alumina form a glass which functions as a matrix of cement holding together the crystals of alumina. The shape and size of these alumina crystals and the amount of matrix present have an important bearing upon the characteristics of the abrasive, and a microscopic study of the internal structure of the abrasive is of great importance.

Fig. 1 is a microphotograph at 8 diameters of an aluminous abrasive of the ordinary type containing about 94 per cent of alumina. The white areas represent crystals of alumina, while the black patches surrounding the white areas represent the matrix holding together the crystals. Fig. 2 is a microphotograph of an aluminous abrasive of the ordinary type containing about 96 per cent alumina, taken by means of polarized light to better bring out the size and shape of the crystals. The average diameter of the alumina crystals is about 0.7 mm. (0.0027 in.). The types of abrasive represented by Figs. 1 and 2 are admirably suited for general grinding and are used in large quantities.

Fig. 3 is a microphotograph taken with polarized light of a thin section of Aloxite "AA." The areas of the same color in the photograph represent the same allotriomorphic crystal of very large size, in some cases hav-

"AA" has an important bearing on the cutting power of the abrasive. As the grits commonly used are 20 and finer, almost every individual grit will consist of a fragment broken from a larger crystal of alumina and due to this fact will possess exceptional sharpness. During the process of grinding there is a breaking down of the abrasive grains in a wheel and the character of the new grains formed depends largely upon the size of the alumina crystals in the original abrasive. When the alumina crystals in the abrasive are small, a rupture of the grain may mean a tearing away of a few small crystals without fracture. However, when the crystals are large and a rupture occurs in an abrasive grain, it means that a crystal of alumina has been actually fractured and that new sharp cutting points and edges have been produced.

A New Type of Manufactured Fuel

A new type of fuel for which remarkable claims are made has been invented by Richard Bowen, managing director of Laminated Coal (Ltd.) The new fuel is produced from coal slack and dust, lignite, peat, or other material, with a binder of pitch.

Put briefly, the inventor's claim is that out of what has so far been regarded as waste material reconstructed coal, in layers or laminations, just as it occurs in the earth, has been produced.

Dust-Conveying Equipment

In the development of machinery and apparatus for the conveying of dust by suction, the Dust Recovering & Conveying Co. of Cleveland, Ohio, has arrived at the production of systems capable of handling material as coarse as ½-in gravel and ⅜-in. iron rivets from cars to bins and about the plant. There are over thirty installations in successful operation at present.

It is possible to empty a box car of bulk cement, ground limestone, raw rock phosphate or similar material at the rate of 8 to 10 tons per hour by simply guiding an intake nozzle through the material.

At first thought it would seem that this method would cause a heavy abrasive action as the materials are carried through the conduits, but it is found in practice that the bulk of the load travels in the center and away from the walls. This, however, is accounted for by the fact that the air travels swiftest in the center where it is not retarded by friction with sides and the conveyed substances follow the path of this current.

A typical installation is shown in the accompanying figure and is located at the plant of the Aluminum Co. of America, East St. Louis, Ill. The material is drawn from cars either through the lower system to dissolving tanks or by the upper and independent system to an overhead screw conveyor to storage.

Each system consists essentially of a receiving station, filter and hopper over discharge outlet; steel pipe lines from station to vacuum pump, and between station and suction nozzles, valve connections in these lines; vacuum pumps; and intake nozzles with armored hose connection.

The filter removes the material from the air and it arrives at the vacuum pump, cleansed from all dust. This permits the use of a standard motor-driven pump.

Other plants installed are handling coke and butt dust, graphite materials, smelter fume, coal dust, bauxite, phosphates, cement products, etc. The adaptation to unloading of many obnoxious materials in chemical works should be especially welcome.

Improved Method of Belt Joining

An unusual problem in the handling of hot cement clinkers with a temperature of 200 deg. and over was recently solved at the plant of the Standard Portland Cement Co., Leeds, Ala., in a cost-reducing manner.

The method decided upon for moving the clinker was a rubber conveyor belt, but the clinker could not be cooled sufficiently in the process previous to conveying to prevent scorching of the belt and its rapid destruction. The answer to this problem was found by running the belt at an incline of 12 deg., so that the lower pulley dipped into a trough of water, thus carrying a film of cold water upon the belt, onto which the hot clinker from the loading hopper was deposited.

At this point a new problem was encountered; namely, how to join the belt so that its full strength would be retained, and in a way which would withstand the extremes of temperature, the wear on the pulleys and the abrasion of the clinker. For this purpose Crescent belt fasteners were adopted, because they brought the belt ends tightly together in a snug joint, making it practically endless on the pulley side, so there was no opportunity for clinker ash to get into the joint and abrade the belt ends, and also because in this method of joining, no metal came in contact with the pulleys to cause wear and a permanent joint was thus assured.

In six months of operation, this conveyor has carried 61,000 tons of clinker, and the Standard Portland Cement Co. credits the saving of $300 in belt cost alone to this conveyor. The belt used was Goodyear Hy-temp, made particularly to withstand temperatures to 200 deg.

Plan

Section　　A - A

Side　Elevation

PNEUMATIC CONVEYING EQUIPMENT
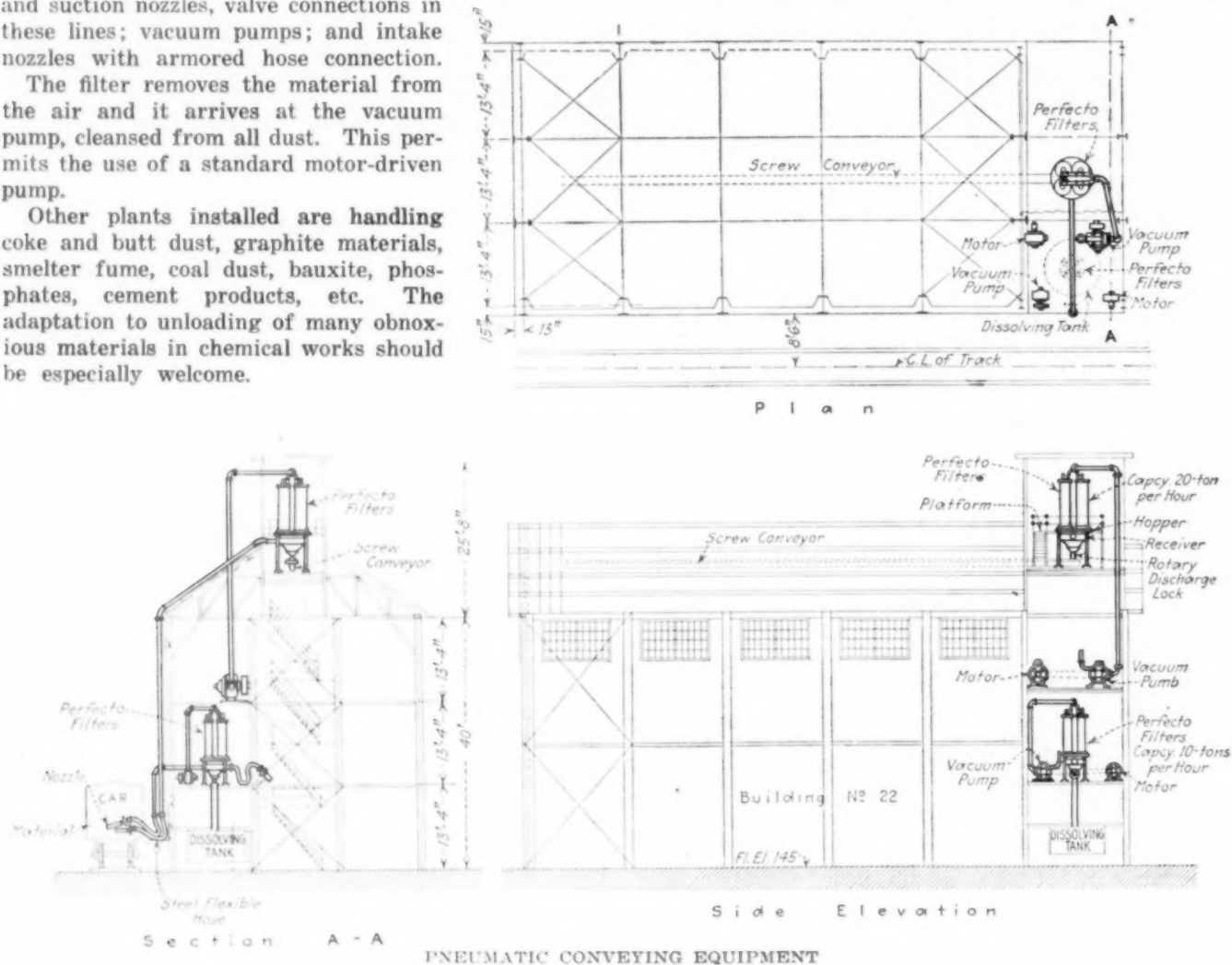
Synopsis of Recent Chemical and Metallurgical Literature

Galvanizing Large Steel Parts by Hot Process.—
A recent issue of *Iron Age* contains a description of the galvanizing plant of the Wellman-Seaver-Morgan Co.,[1] at Akron, Ohio, including details of the hot process and of the galvanizing kettle, which is of unusual size. The extreme dimensions of material which can be handled are: length, 19 ft. 6 in.; width, 3 ft. 4 in.; height, 7 ft.

Parts to be galvanized must first be thoroughly cleaned by the use of lye solution (to remove oil, grease, etc.) or a wire brush (for marking paint, heavy rust, etc.), followed by pickling. The pickling solution contains H_2SO_4 and water in the proportion of 1 to 15 by weight. About 75 lb. of 66 deg. H_2SO_4 is used per ton of steel. The solution is maintained at a temperature of about 100 deg. F. by means of steam coils. Considerable experience is required to determine when pickling is complete. In over-pickled articles the fibers of the metal are visible and the part will take a heavier coat when galvanized, which is liable to peel off through vibration.

After pickling, the article is washed with warm water in the rinse tank and then immersed in the muriatic acid tank, which contains acid and water in the proportion of 1 to 15 by weight. This solution is also heated. About 75 lb. of 18 deg. hydrochloric acid is required per ton of steel.

The article is now suspended over the galvanizing kettle, where it is thoroughly dried by the radiated heat. Before immersing in the molten zinc, the surface of the article is sprinkled with powdered ammonium chloride. The surface of the zinc bath is skimmed of zinc oxide and the article entered into the bath at the predetermined rate, which is about 10 ft. per min. for sheets. The zinc becomes greatly agitated at the points of immersion and the piece is not withdrawn for several moments after this agitation has ceased. During withdrawal, which is done at the same speed as immersion, the article is carefully examined for uncoated spots.

The ammonium chloride (or sal ammoniac) melts on the surface of the bath and gradually dissolves zinc oxide until it becomes an impure, sticky mass which is skimmed off and sold as "sal ammoniac skimmings" to chemical manufacturers. In galvanizing large sheets and tanks, an average of 5 lb. is used per ton of steel.

The 50-lb. pigs of zinc or spelter used analyze: Zinc, 99.77; lead, 0.19; iron, 0.04. The amount of zinc per sq.ft. of surface galavanized averages from 1 to 2 oz., depending on the texture of the metal and the time of immersion. The working temperature of the bath is about 800 deg. F. A great improvement can be made in the appearance of galvanized surfaces by adding a very little aluminum to the molten bath.

The acid tanks and the water tank have inside dimensions 19 x 4 x 7 ft. deep. The two acid tanks are of 6-in. double-keyed Oregon fir, with bolts and nuts encased in lead, while the water tank is of 3-in. Oregon fir. All joints are made with white lead. Each tank contains a 50-ft. steam coil of 1-in. lead pipe.

[1]"Galvanizing Plant Handles Large Work," A. H. Myers, *Iron Age*, vol. 105, p. 181, Jan. 15, 1920.

The galvanizing kettle (inside dimensions, 20 ft. x 3 ft. 6 in. x 7 ft. 6 in. deep) has side plates of 1¼-in. fire-box steel and end and bottom plates of 1-in. flange or boiler steel. There are ten fire chambers on each side of the kettle, five being gas fired and five coke fired. Either one of the firing systems is ample for the operation of the kettle, 2,000 lb. of byproduct coke or 40,000 cu.ft. natural gas per 24 hr. being required.

The kettle when full contains 200,000 lb. of zinc and about seven days are required to prepare the bath. In starting, the pigs are carefully piled endwise into the kettle until full and pieces of sheet iron are placed over the top to retain as much heat as possible. Heat is applied gradually, and at the end of four days the kettle is full of molten zinc. There will be quite an accumulation of zinc ashes (oxide) on the surface. These ashes sometimes contain considerable zinc which is melted out by throwing on and igniting several handfuls of resin. The zinc ashes are raked over during the burning of the resin in order to hasten the operation and are then skimmed off. The kettle is now ready for duty. While the kettle is in operation, some of the zinc forms an alloy with the iron of the kettle. Since the kettle is heated at the sides, this alloy settles to the bottom as dross which is removed from time to time and cast into pigs weighing about 125 lb.

In designing the first kettle installed at this plant, no provision was made for reinforcing the sides of the tank to counteract the hydrostatic pressure of the liquid metal. This pressure will be considerable in a long, deep kettle, since molten zinc has a specific gravity of 6.48. As a result, the kettle soon spread a distance of 13 in. in the center at the top. The sides were then reinforced by a pair of special cast iron braces, which were designed as beams with concentrated loads equal distances apart. The calculations involved are given in detail in the original paper.

Cast Iron as a Chemical Engineering Material.—
At the January meeting of the Philadelphia Section of the American Chemical Society, HOWARD A. HOFFER, of the United States Cast Iron Pipe & Foundry Co., presented a paper on "The Manufacture of Cast-Iron Equipment Used in Chemical Engineering." An interesting report of this lecture will be found in the February *Catalyst*.

Cast iron is not acted upon by many of the chemicals used in industry and, consequently, it plays an important part in the equipment of a chemical manufacturing plant. In many instances, the major operations take place in cast-iron apparatus, such as nitrators, sulphonators, nitric acid retorts, caustic soda fusion kettles, crystallizers, digesters, autoclaves, etc. In general, the metal composition depends upon the temperature of the reaction taking place in the apparatus, as well as the concentration and chemical nature of the reacting substances.

Cast-iron water pipe is cited as an excellent example of the resistance of cast iron to corrosion. This use of cast iron dates back to 1664, when fifteen miles of pipe was laid by order of Louis XIV to supply the reservoirs in the park at Versailles. This pipe is still in use and in excellent condition after more than 250 years of service.

The most modern and practical method of making cast-iron pipe is in vertical dry sand mold, bell end down, without the use of chaplets, and casting with a shrinkhead so as to avoid the segregation of dross,

occluded gases or foreign material. In making pipe or castings intended for chemical processes chaplets should be eliminated when centering the core in the mold. This is necessary to avoid electrolytic corrosion, as a galvanic current would be generated because of the difference in potential of the metal in the chaplet and in the casting, the chemical solution in the casting acting as the electrolyte.

Cast-iron pipe is being widely used in chemical works for conveying acids, alkalis and other corrosive chemicals. In sulphuric acid work, it is used for carrying acid of 50 to 60 deg. Bé. and also for concentrating from 60 to 66 deg. Bé. At ordinary temperatures, acid down to 1.53 sp. gr. has very little effect upon cast iron, if excess of air is excluded. This material is not recommended for acid between 50 deg. Bé. and 8 per cent H_2SO_4. It is used, however, for weak acid solutions (1 to 3 per cent).

Iron apparatus for acid between 3 and 10 per cent is usually lead-lined, as in the case of ammonia saturators used for the manufacture of ammonium sulphate by the direct process.

In the manufacture of sulphuric acid, hot and cold SO_2 is carried in cast-iron pipes and the hot H_2SO_4 is cooled in cast-iron coils. Other uses for cast-iron pipe are: In mines, for handling acid mine waters; in acid soils; in stoker feed pipes, where the abrasion by the coal and the corrosion by the sulphur content cause rapid deterioration of rolled metal pipe; in byproduct coke plants for conveying the gases from the ovens, the coal tar and oils produced by the condensation of these gases, ammonia, and the solvents used for the extraction of benzol and toluol in the scrubbing towers.

Since many chemical processes require high temperatures, it is of interest to note that the tensile strength of soft cast iron remains practically constant from 100 to 1,000 deg. F., while the ultimate strengths of steel and wrought iron decrease rapidly beyond 450 deg. F. Reports from fire underwriters and fire engineers indicate that cast-iron columns will withstand 1,500 deg. F. without bending and still carry the super-imposed load, while steel columns fail at about 1,000 deg. F. Cast-iron retorts are extensively used in the chemical and allied industries at temperatures between 1,200 and 1,500 deg. F., although the life of the equipment is, of course, shorter than at lower temperatures.

Japanese Rubber Industry.—The Japanese rubber industry has made great strides since the outbreak of war. It is expected, says the *Japan Chronicle,* that orders for rubber goods will flow in from Europe, and, indeed, the exports of rubber tires during the present year have been enormous. A further development of the industry is looked for in the shape of a combination of large and small rubber factories. The desirability of this scheme seems now to have been accelerated by the receipt of large orders from Siberia. The *Chronicle* continues:

> The Okura firm is said to have recently received from the new Siberian Government orders for about 400,000 yen ($199,400) worth of rubber tube and 200,000 yen ($99,700) worth of rubber sheet. The company has now given these orders to the Mitado, the Toyo, the Nippon, and the Meiji rubber companies, which are regarded as the best rubber works in Japan, apart from foreign enterprises established here, the Okura-

gumi guaranteeing payment. In this connection it is said that these have decided to fill the Russian orders in co-operation with one another, so as to avoid unnecessary competition—or so as to be able to compete with a Kobe company. Their co-operation is said to extend as far as exchange of stocks and of orders for the purpose of securing efficiency and economy.

This co-operation is said to portend amalgamation at an early date, so as to put the rubber industry in Japan on a firm foundation. They are also expected to extend their combination to other factories after this first step.

Recent Chemical and Metallurgical Patents

British Patents

Purifying Saccharine Liquids.—Sugar liquids are decolorized and freed from mineral substances by means of alumina or magnesia or analogous substances occurring naturally, such as bauxite or magnesite. The material, mixed with carbon or carbonaceous matter, is ignited and granulated. The liquor to be treated is filtered through the material or may be agitated with it and filtered through a filterpress. Aluminum nitrate or chloride, or calcium or sodium phosphate may be added to the liquor before treatment. (Br. Pat. 134,607 —1919. J. J. Hood, London; J. Clark, Hutton, and P. G. Clark, London. Jan. 7, 1920.)

Plastic Composition.—Ground vegetable ivory is mixed with casein, lime and water and, optionally, sodium silicate, and the product is fused for making buttons, etc. An example of proportions is 12 parts ground vegetable ivory, 3 parts casein, 2 parts lime, ½ part sodium silicate. (Br. Pat. 134,619—1919. G. C. Devonshire, London, and E. T. Ford, Birmingham. Jan. 7, 1920.)

Cracking Hydrocarbons.—In cracking hydrocarbons and more particularly in converting tar oil into benzol and mineral oil into benzine, by passing a mixture of hydrocarbon vapors and steam over a heated carbonaceous material such as coke, the operation is effected in a zone of high temperature with zones of lower temperature on either side. The apparatus consists of vertical or inclined retorts through which the vapor mixture is passed upward. The central zone is heated to 500-1,200 deg. C. and the top and bottom of the retorts are kept at about 300 deg. C. The central zone extends about one-sixth to one-half of the total length of the retort, and the total height of the packing to between one-half and three-quarters of the total length. The low temperature zones may be packed with porcelain, etc. The temperature at the bottom of the retort is maintained by pre-heating the vapor mixture, and the temperature and extent of the central zone are regulated by manipulating dampers in the flues. Carbolic and creosote oils require a shorter high-temperature zone and a smaller admixture of steam than anthracene oil. The proportion of oil to water varies between 1 : 2 and 2 : 1 by volume. (Br. Pat. 135,197—1919. Naamlooze Vennootschap Nederlandsche Lichte Olie Maatschappij, Amsterdam. Jan. 21, 1920.)

American Patents

High-Phosphorus Pig Iron From Glauconite. — THOMAS C. MEADOWS, of New York City, patents the process of charging a blast furnace with a suitable mixture of iron-potassium minerals (such as glauconite) with an iron-bearing phosphate rock, together with fluxes such as iron ore, lime rock, or silica sand, according to the exigencies of the case. As a result he procures a high-phosphorus pig iron and volatile products rich in potash. Potassium-carbon-nitrogen compounds might be recovered if drawn from the furnace near the focus before they have been broken up by reducing the descending charge. (1,322,038; Nov. 18, 1919.)

Electric Furnace. — A compact and easily operated tilting electric furnace of the resistance type has been designed by WILLIAM H. BRISTOL and M. J. JOHNSON; the features of interest are shown in the figure. The furnace is supported on pedestals and can be rotated on trunnions resting in insulated bearing 15. Water-cooled electrodes 24 and 25 are attached to the end plates 12, which are spaced by the distance rods 13. The electrodes are cooled by water which flows in through pipes 14 and out through pipes 26. One particular feature of the furnace is the method of
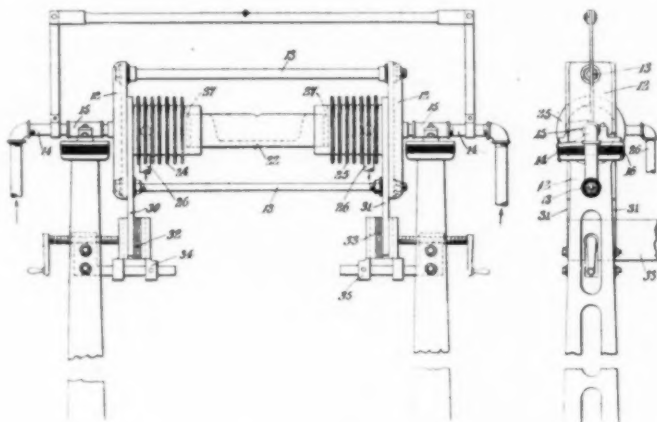
making contact between the carbon resistor 22 and the electrodes 24 and 25. The resistor is slipped into place through the open top of the electrodes and contact is made by inserting a graphite plate 27 between the face of the electrodes and the resistor. This effectively reduces the arcing which is usual in furnaces of this type. Another feature is the method of carrying the current from the busbars to the electrodes. Conducting plates 30 and 31 attached to the electrode are so arranged that they may be clamped by means of the clamps 34 and 35 to the conductor bars 32 and 33. This does away with the use of flexible cables. The resistor is enclosed in heat-insulating material not shown in the illustration. (1,323,576, Dec. 2, 1919; assigned to the Bristol Co. of Waterbury, Conn.)

Purification of Crude Anthraquinone. — Crude anthraquinone, produced by the oxidation of anthracene, is a mixture of the following compounds:

	Melting Point Deg. C.	Boiling Point Deg. C.
Anthracene	213	351
Anthraquinone	285	382
Phenanthrene	99	340
Phenanthraquinone	198	360
Methyl anthracene	190	360
Methyl anthraquinone	170	+360

These may be separated by a process described by CHESTER E. ANDREWS, of Pittsburgh, Pa. The crude material is heated in a current of air or other inert gas to a temperature of about 300 deg. C. The substance having the lowest boiling point will tend to vaporize first. The vapors are carried to a condensing chamber consisting of a number of compartments of successively increasing height, separated by screens of wire gauze. The process of separation is completed in these chambers by fractional condensation. By means of suspended weights, accumulations of sublimate may be jarred loose from the screens. (1,324,-716; assigned to the Selden Co.; Dec. 9, 1919.)

Treatment of Anthracene Press-Cake. — The process of fractional vaporization and condensation described in U. S. P. 1,324,716 granted to CHESTER E. ANDREWS, of Pittsburgh, Pa., is also used by the inventor for the treatment of crude anthracene press-cake containing 60 to 70 per cent of impurities which consist principally of phenanthrene, methyl anthracene and carbazol. The press-cake is first treated with sufficient sodium hydroxide solution to convert the carbazol into its sodium salt. The mass is then heated to 250 deg. C. in a current of air. The vapors condense in the following order: Anthracene, methyl anthracene, phenanthrene. The residue (the sodium salt of carbazol) is dissolved in water, filtered, recrystallized, and acidified to precipitate carbazol in a relatively pure state. (1,324,717; assigned to the Selden Co.; Dec. 9, 1919.)

Nitrogen-Hydrogen Mixture. — For the production of ammonia by catalysis, the nitrogen-hydrogen mixture should be as free as possible from O_2, H_2O, sulphur compounds and CO_2, but for some catalysts small amounts of CO do not appear to be injurious except as diluents. Such a mixture may be prepared by the following method, devised by CARLETON ELLIS, of Montclair, N. J. Air and steam are blown through a gas generator fed with coal or coke low in volatile hydrocarbons. The gas obtained has the composition: Hydrogen, 15 per cent; carbon monoxide, 20 per cent; carbon dioxide, 2 per cent; nitrogen, 63 per cent; sulphur, etc., traces. After removing CO_2 and sulphur compounds by passing over lime or ferric oxide, and CO by compression, this "water-producer gas" will contain hydrogen and nitrogen in the ratio of approximately 1 : 4 by volume. This is preferably enriched, before using, by the addition of electrolytic hydrogen, in order to bring the ratio of hydrogen to nitrogen up to 1 : 3. Byproduct hydrogen from electrolytic chlorine cells may be purified by passing over platinized asbestos, whereby the oxygen and chlorine unite with the hydrogen to form water and hydrochloric acid, which may be easily removed by condensation or by passage over lime. (1,327,029; assigned to Clinton S. Lutkins; Jan. 6, 1920.)

Dyes From Halogenated Hydroxynapthoquinones. — By adding three to four parts by weight of bromine to a solution of one part by weight of juglon (5-hydroxy-ɑ-napthoquinone) in fifteen to twenty parts of glacial acetic acid, ALVIN S. WHEELER, of Chapel Hill, N. C., obtains 2.3.8-tribrom-5-hydroxynaphthoquinone, having a melting point of about 170 deg. C. The sodium salt of this compound may be made by dissolving in ether and shaking this solution with an aqueous solution of sodium carbonate. The salt, which separates out as a purplish deposit, is soluble in water, and dyes silk and wool directly. The sodium salt of dichlor-juglon has similar properties as a dyestuff. (1,327,-260; Jan. 6, 1920.)

Sodium Carbonate From Alkaline Brines.—Theoretically, in the treatment of Searles Lake brine for the recovery of alkali by precipitating sodium bicarbonate, the subsequent conversion of the latter salt into sodium carbonate should liberate enough CO_2 to precipitate an equivalent amount of bicarbonate. Losses of CO_2 are, however, unavoidable. NATHANIEL T. BACON of Peace Dale, R. I., suggests that the precipitation be started with flue gas, the purer CO_2 being reserved for final treatment. (1,330,573; assigned to the Solvay Process Co.; Feb. 10, 1920.)

Book Reviews

QUANTITATIVE ANALYSIS. By *Edward G. Mahin, Ph. D.*, professor of analytical chemistry in Purdue University. 2nd edition, revised and enlarged. 605 pp. 122 figs. New York: McGraw-Hill Book Co., Inc. Price, $3.50.

The scope of this work is so complete as to cover practically all the phases of quantitative work required of a student in a thorough modern course in chemistry. In the present edition, methods have been revised in accordance with the latest standardized procedures and new methods have been included. The treatment of each subject is exceptionally clear and there is complete freedom from any tendency toward "cook-book" style. The theory of each procedure is discussed fully, using the principles of physical chemistry wherever applicable, so that the analyst is enabled to approach a problem with a full appreciation of the limitations of the method, the possibilities of error and methods of avoiding the latter.

For the benefit of those who are unfamiliar with the earlier edition of Prof. Mahin's work, the following summary of the topics treated may be of interest:

The main divisions of the book are two—general quantitative analysis and analysis of industrial products and raw materials. A short introductory chapter on general principles is followed by a seventy-one page discussion of the methods and apparatus used in gravimetric analysis. The experiments in the next chapter include, in addition to the usual determinations, the separation of chlorine, bromine and iodine by selective oxidation. Chapter IV is devoted to the theory and practice of electro-analysis, including the use of the mercury cathode. The next three chapters cover the manipulations of volumetric analysis, the theory of indicators and the preparation of standard solutions, and prepare the student for the experiments. Chapter X takes up the important subject of oxidation and reduction in relation to volumetric analysis. Part I concludes with a discussion of titrations involving the formation of precipitates.

Rock analysis is considered first in Part II, followed by chapters on fuels (coal and gas analysis), oils, fats and waxes (burning oils, lubricating oils, edible fats and oils), and water analysis from the industrial and sanitary standpoints. Chapter XV treats the chemical and metallographical analysis of iron, plain steel and alloy steels and the chemical analysis of brass, bronze and bearing metals. The following chapter on agricultural materials covers fertilizers, milk, cream, condensed milk, butter and butter substitutes. A section on the fire assay of gold and silver ores completes the text. Four place tables of logarithms and antilogarithms, and a good index add to the usefulness of the volume.   ALAN G. WIKOFF.

Obituary

Dr. J. J. ELBERT, a technologist with the American Cyanamid Co., died suddenly at his home in Tuckahoe, N. Y., on Feb. 27. He was a graduate in chemical engineering of the Massachusetts Institute of Technology and of the University of Berlin. Dr. Elbert, after returning from abroad, was general manager of the Fibre Finishing Co., Worcester, Mass. He then associated himself with the General Chemical Co., being located in its Laurel Hill laboratories for nearly a year and later transferred to the Delaware works at Marcus Hook, Pa. For the past four years he was with the American Cyanamid Co., first as technologist, later as superintendent of the Warners plant. When the Muscle Shoals plant was ready for operation, Dr. Elbert was made assistant superintendent in charge of ammonia production, nitric acid and ammonium nitrate divisions. With the closing down of that plant, he returned to New York, where he again entered the technical department of the American Cyanamid Co. He was a member of the American Electrochemical Society and the American Chemical Society.

FRANKLIN MURPHY, former Governor of New Jersey and head of the Murphy Varnish Co., passed away Feb. 24, after an operation.

Personal

Dr. LEO H. BAEKELAND is traveling through South America in the interests of the establishment of closer relations between North and South American universities. He expects to be back in this country late in April or early in May.

R. E. COLLUM, petroleum technologist of the U. S. Bureau of Mines, has changed his headquarters from San Francisco to Dallas, Tex., where he will be in charge of the Bureau's office.

ARTHUR L. DAY, formerly the director of the Geophysical Laboratory, Washington, has announced that he will sever his connection with the Corning Glass Co. on April 1 and resume active direction of the work of the Geophysical Laboratory. GEORGE W. MOREY of the same institution is expected to return to Washington to resume his research work there about the first of May. During and since the war period he has been with the Spencer Lens Co. in its optical glass work.

DAVID F. GOULD, formerly assistant chemist in the research laboratory of the Mexican Petroleum Corporation, Destrahan, La., is now research chemist with the chemical department of The Barrett Co., Frankford, Pa.

HERMAN A. HOLZ, president of Holz & Co., Inc., New York, manufacturer of metallurgical testing and research apparatus, recently left for an extended trip through Europe to study the latest European developments in metal-testing methods and in the design of testing equipment.

N. L. BOWEN will sever his connection with Queen's University, Kingston, Ont., at the end of the present college year, to take up his former position at the Geophysical Laboratory, Washington.

R. E. HALL has resigned from the Geophysical Laboratory to accept a position with the Firestone Tire & Rubber Co., Akron, Ohio.

Dr. P. E. LANDOLT, of the Research Corporation, New York, delivered a lecture on "The Cottrell Electrical Precipitation Process" Saturday evening, March 20.

Dr. HORACE C. PORTER, formerly of the Bureau of Mines, later chemical engineer with the Koppers Co., Pittsburgh, and since the close of the war associated with the Chemical Service Laboratories, Inc., of West Conshohocken, Pa., has established an office and laboratory at 1833 Chestnut St., Philadelphia, for consulting work on fuels. Dr. Porter will make a specialty of carbonization, coking, gas and byproducts, valuation of coals, fusibility of ash, and fuel research.

E. GYBBON SPILSBURY has returned from Brazil, where he has spent the last few months in exhaustive examination of the iron and manganese resources and possibilities of utilizing native coal for their reduction.

ARTHUR L. WALKER, professor of metallurgy, Columbia University, is delivering a course of lectures on non-ferrous metallurgy before classes of the new engineering school at Harvard University. The first lecture was delivered the middle of February.

Current Market Reports

The Non-Ferrous Metal Market

New York, March 22, 1920.—The market remains quiet. Copper dropped off ¼c. in the last week, but strong inquiries developed. Tin declined sharply, from 63c. to 61¼c. for spot.

		Cents per Lb.
Copper, electrolytic		18.50
Aluminum, 98 to 99 per cent		31@32
Antimony, wholesale lots		11.00
Nickel, ordinary		43.00
Nickel, electrolytic		45.00
Tin, Straits, spot		61.50
Lead, New York, spot		9.00
Lead, E. St. Louis, spot		8.87½
Zinc, spot, New York		8.70
Zinc, spot, E. St. Louis		8.37½

OTHER METALS

Silver	oz.	$1.21
Cadmium	lb.	1.50
Cobalt	lb.	1.50
Magnesium (f. o. b. Niagara Falls)	lb.	1.60
Platinum	oz.	150.00
Iridium	oz.	250.00
Palladium	oz.	150.00
Mercury	75 lb.	93.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	27.50
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	33.50
Seamless bronze tubing	34.50
Seamless brass tubing	32.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	22½@23½
Aluminum, sheet scrap	22@22½
Aluminum clippings	25½@26½
Copper, heavy machinery comp	15@15½
Copper, heavy and wire	13½@14½
Copper, light and bottoms	12@12½
Copper, heavy cut and crucible	15@15½
Brass, heavy	7@7½
Brass, casting	10@10½
Brass, light	5½@6½
No. 1 clean brass turnings	7½@7½
No. 1 comp. turnings	11½@11½
Lead, tea	5½@5½
Lead, heavy	7@7½
Zinc, scrap	4½@4½

The Iron and Steel Market

Pittsburgh, Pa., March 19, 1920.

The trade has given considerable attention to the steel ingot production report for February, made public a trifle over a week ago and referred to in last report. It may be recalled that the report indicated that steel ingots were produced during February at the rate of 44,200,000 gross tons per annum.

It is somewhat like the case of a single equation with one known quantity and two variables. The steel actually was produced, but reports during February were that mills were operating at far below capacity, say at not over 80 per cent on an average, while the most acceptable estimate of capacity, as mentioned in this report a week ago, was about 50,000,000 tons. Thus the actual production was 88 per cent of the estimated capacity, but if production were only 80 per cent of capacity the capacity would be 55,000,000 tons. The common opinion in the trade is that there was no great exaggeration of the curtailment in output occasioned by the weather, by the poor transportation service and by some minor contributing causes, but that rather the capacity is going to be found greater, on the test that favorable manufacturing conditions will eventually permit, than has been estimated on the basis hitherto used, that of taking 1916 production as the average capacity for that year and allowing conservatively for the new construction.

The argument furnishes another illustration of the errors that may be fostered by trying to interpret isolated facts into terms of steel market conditions and prospects. For steel mills to be operating at far below capacity in February constituted an augury that steel would be scarce, while for capacity to be found materially greater than had been assumed constitutes an augury that steel will be in better supply as the temporary barriers to full production disappear. That they will disappear is, of course, obvious.

STEEL SCARCITY LESS WIDESPREAD

In the past week many indications have developed of the steel scarcity being less widespread than formerly. Not a few manufacturing consumers find themselves well supplied now, through the combined influence of mill productions being larger, mill accumulations being reduced as car supplies improved, and the time in which steel is in transit being reduced. There had been many cases of steel being two or three times as long in transit as the normal experience. At the present time receipts are therefore greater than shipments.

The pressure for prompt deliveries of steel has sensibly decreased of late. Stocks for sale are practically nil, and there is little unsold steel for delivery between now and July 1, yet there is a perceptible softening in prompt delivery prices in general. From the relatively new viewpoint, that there is no real "runaway market" in steel prices but that prompt delivery prices simply contain a delivery premium over basis prices for late deliveries, the delivery premiums are declining. The only noteworthy actual decline is in sheets, which in the past ten days have not commanded over 8c. in actual mill sales, for early shipment, while in the last week of February there had been a number of sales, of relatively small lots of course, at 10c. basis. The Industrial Board schedule, whose anniversary is about here, set sheets at 4.35c., and that price not only has been adhered to by the Steel Corporation but will, in all probability, be announced April 15 or shortly afterward as the corporation's price for second half deliveries to manufacturing consumers and third quarter deliveries to jobbers. The prices mentioned refer to common black, 28 gage, but the fancy priced sales of late have not been of common black but of special finish sheets, chiefly for the automobile trade, at the base prices mentioned plus regular extras for finish.

PRICES ON BARS, SHAPES AND PLATES

Mention has been made in these reports of the likelihood that some large independents would soon open their order books on bars, shapes and plates for third quarter deliveries to regular customers at not over 3c., 3.10c. and 3.25c. respectively. It is now well assured that the prices will not be higher than just mentioned, and they may be somewhat lower, particularly to large customers. Thus the forward delivery market of the independents is not advancing, though it remains at well above the Steel Corporation level, bars and shapes as just quoted being $13 a ton and plates $12 a ton above the Industrial Board schedule, effective March 21, 1919.

The Steel Corporation shows no disposition whatever to advance its prices, and thus eventually, unless fundamental conditions on which the policy is based change, the independent prices will come down to the corporation level. That will not be for some time to come, as delivery premiums, involving really early deliveries, must first greatly decline if not disappear entirely, and such a decline has only started.

PIG IRON

The pig-iron market presents interesting possibilities. Most of the information available as to this district indicates that the market is soft, with prospects that interesting inquiries would bring out lower quotations. There is no delivery premium, an unprecedented condition when there is a high market. Some Eastern steel works are offering basic iron as far west as Pittsburgh, and a large valley interest, which used to buy pig iron when operating full, expects this time to have a surplus for sale instead.

On the other hand, reports from the Philadelphia and Buffalo markets are of tight conditions and a visible scarcity of iron. It is between buying movements in Pittsburgh and at such times the market prospects are frequently not clearly defined. The advance which sent pig iron from $18 in August, 1916, to over $50 in the following July began with sales in a dull market at cut prices. The present local

market appears to be quotable, as for the past two or three weeks, at $42 for bessemer, $41.50 for basic and $42 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.40, but should important business develop these quotations might be found to have been largely nominal.

STEEL

There is not much inquiry for billets, but considerable tonnages could probably be sold if early deliveries could be offered. For both billets and slabs the market for prompt shipment seems to be $65 to $70, with small billets at perhaps $10 more. The especially fancy priced sales of sheet bars, at $90 and thereabout, appear to have ceased, the market being quotable generally at $70@$80, depending on the standing of the buyer. One interest has covered regular customers for second quarter at $60, but that is not a market price, representing a sort of compromise in consideration of the fact that the Steel Corporation is still taking care of its customers as far as it can at the old Industrial Board price of $42.

FERRO-ALLOYS

Producers have advanced ferromanganese, formerly $160, to $180 as minimum, some quotations of $200 being out. These prices are for second half, delivered, 78 to 80 per cent. Earlier deliveries run up to $225 or higher, but involve only very small lots. English is out of the market, there being no fresh quotations, though with such high domestic prices English is likely to become a factor again. Electrolytic ferrosilicon is $80@$81, delivered, for 50 per cent and $140 for 75 per cent. Bessemer ferrosilicon is $59.50 for 10 per cent, $62.80 for 11 per cent and $66.10 for 12 per cent, f.o.b. furnaces at Jackson and New Straitsville, Ohio.

Chemical and Allied Industrial Markets

New York, March 20, 1920.

General conditions remain practically unchanged, with the spot market a little tighter if anything. Any price movement recorded has been upward, especially in the alkali group. Under the influence of the more favorable rate of exchange foreign inquiry has picked up slightly.

GENERAL CHEMICALS

Ethyl alcohol has advanced again and the present low mark is $5.25 per gal., with difficulty in obtaining any material even at this price. In sympathy with ethyl grade, *methyl* has also advanced, the nominal quotation for 95 per cent being $2.25, while actual sales are reported as high as $3.50, and prices as high as $5 have been received for 97 per cent pure. *Denatured* has been advanced 20c. a gal., present quotations reading $1 for 188 and 96c. for 190 proof. This advance was brought about by the loss of two tank steamers of molasses, belonging to a controlling factor in this market, from which several million gallons of alcohol were to be obtained. *Methyl* alcohol is on the advance due to unfavorable labor conditions among the unskilled labor of the South, but it is the opinion of one large factor in the market that this condition will be easier around the beginning of May. *Sodium nitrite* fell back and although there is very little material on the spot market contract prices are going back to normal. Spot prices range from 50c.@60c. per lb. *Sodium bichromate* holds firm at 33c.@35c. per lb., some small supplies on the spot market going at a slightly higher price. *Oxalic crystals*, under pressure of heavy demand, advanced 3c. per lb., the present quotation being 43c.@48c. per lb. for spot and 35c@42c. for carlots on contract. *Barium chloride* is slightly easier, $140@$150 being the spot price and $125@$135 per ton for contracts. It is reported that one large producer who has been out of this market for some time past has come back, and with larger supplies the present scale of prices should be broken.

It is reported that producers are completely sold out on *acetic acid*, glacial, 99½ per cent. The spot market is somewhat tighter with $15@$15.50 per cwt. the best quotation. This condition will continue till the end of the summer, by

which time it is hoped manufacturers will be caught up on their contracts. *Sal soda* holds firm at $1.25@$1.35 per cwt. for carlots and $1.40@$1.50 on spot. Buying on spot market increased during the past week, which forced material in second hands up slightly. *Sodium borate* holds firm on contract price at 8¼c.@8¾c. per lb., while the spot market advanced to 9c.@9½c. *Formaldehyde* is still at a premium on the spot market, being listed at 90c.@$1 per lb. The nominal market price of 38c.@40c. still solds, but there is no material to be had at these prices on contract.

COAL-TAR PRODUCTS

The coal-tar products market remains in the same position in which it was last week. Very few price changes have occurred and except for further advance of spot materials there is very little to report. It is the opinion of those engaged in this industry that there is no relief in sight from the current high prices. The demand continues heavy, with very little material being offered for immediate delivery. *Salicylic acid* holds firm at 55c.@60c. per lb. for U. S. P., while the *technical* grade, under the influence of more active demand, increased to 45c.@50c. per lb. The spot market on *aniline oil* continues cramped, but prices are holding firm at 34c.@45c. per lb., while the *salts* are practically unobtainable, with a nominal quotation of 42c.@48c. per lb. All grades of *beta naphthol* are very scarce and prices ranging from 75c.@$1 per lb. are being offered. Quotations on *H acid* remain nominal, as there is practically no material available on the spot market.

WAXES

The wax market has dropped slightly during the past week due to the arrival from abroad of several shipments of beeswax and carnauba. Spot material in these two lines dropped, with 38c.@40c. per lb. being asked for natural crude yellow beeswax, while *carnauba*, No. 3, North Country, dropped to 43c.@45c. per lb.

FLOTATION OILS

There has been a general advance in flotation oils during the past week, caused by shortage of supplies. Manufacturers are not able to meet the demand because of the inefficiency of the laborers. *Pine oil*, steam dist., sp.gr. 0.930-0.940, is quoted at $1.65 per gal.

NAVAL STORES

The market continues quiet with a further drop in the *rosins*. It is reported that the difficulty the producer in the South is having with labor has caused a shortage, which, coupled with decreasing domestic demand and very inactive foreign inquiry, accounts for the present declining market. B-D grades are listed at $17.50@$18, E-I grades at $17.50@$19 and WG-WW at $22@$22.50 per 280 lb.

Turpentine is quoted higher than it ever has been before, not excepting war prices. Supplies are extremely low in Savannah and no relief is expected until the new crop arrives. The jump of 15c. during the past week places turpentine at a nominal quotation of $2.20 per gal. It is the general opinion of those engaged in the trade that the limit has not been reached but will continue upward till relief from the new crop is received.

VEGETABLE OILS

The oil market during the past week remains in practically the same position. *Linseed* oil, raw, carlots, is firmer at $1.84 per gal., while boiled, carlots, is bringing $1.87. *Cottonseed* holds firm at former levels with the usual fluctuations during the week but ending at the same price. *Ceylon* grade, in bbl., 18c.@19½c. per lb. and *Cochin* grade, 20½c.@23c. per lb.

ORES AND SEMI-FINISHED PRODUCTS

The *tungsten* bill which has been before the Senate for consideration for some time has again been sidetracked. There has been practically no business on this item and as low as $6 has been received on *wolframite*. The *manganese* market holds firm under the pressure of demand for ferromanganese.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.60 – $0.65
Acetone	lb.	$0.13 – $0.15	.16 – .18
Acid, acetic, 28 per cent	cwt.	2.75 – 3.00	3.00 – 3.25
Acetic, 56 per cent	cwt.	6.00 – 6.50	7.00 – 7.50
Acetic, glacial, 99½ per cent, arboy †	cwt.	12.00 – 14.00	15.00 – 15.50
Boric, crystals	lb.	.14½ – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Hydrochloric	lb.	.08 –	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.14 –
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.05 – .06	.05½ – .07
Molybdic, C. P.	lb.	—	4.25 – 5.00
Nitric, 40 deg.	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg.	lb.	.06½ – .07	.68 – .09½
Oxalic, crystals †	lb.	.35 – .42	.43 – .48
Phosphoric, Ortho, 50 per cent solution	lb.	.24 –	—
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	17.50 – 22.00	
Sulphuric, 60 deg., drums	ton		
Sulphuric, 66 deg., tank cars	ton	22.00 – 25.00	
Sulphuric, 66 deg., drums	ton		
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars		27.00 – 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums		32.00 –	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	35.00 –	40.00 –
Tannic, U. S. P.	lb.	—	1.35 – 1.45
Tannic (tech.)	lb.	—	.42 – .55
Tartaric, crystals	lb.	—	.69 – .74
Tungstic, per lb. of WO	lb.	—	1.20 – 1.40
Alcohol, Ethyl (nominal) †	gal.	5.25 – 5.50	6.00 – 7.00
Alcohol, Methyl (nominal) †	gal.	2.35 – 2.75	
Alcohol, denatured, 188 proof (nominal) †	gal.	—	1.00 – 1.05
Alcohol, denatured, 190 proof (nominal) †	gal.	—	.96 – .98
Alum, ammonia lump	lb.	.04 – .05	.05½ – .06
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03½ – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ – .10½	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.35 – .37
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15 – .16	.17 – .19
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.10 – .12	—
Ammonium sulphate	lb.	.05 –	.06 –
Amylacetate	gal.	—	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	—	.10½ – .11
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	
Barium chloride †	ton	125.00 – 135.00	140.00 – 150.00
Barium dioxide (peroxide)	lb.	.26 – .27	.28 – .30
Barium nitrate	lb.	.11 – .12	.13 – .14
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.05½ – .06
Bleaching powder (see calcium hypochlorite)			
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	
Brimstone (see sulphur, roll)			
Bromine	lb.	.85 – .95	
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	—	.04½ – .05
Calcium chloride, fused, lump	ton	20.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01½	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	3.50 – 3.75	4.00 – 4.50
Calcium peroxide	lb.	—	1.50 – 1.70
Calcium phosphate, monobasic	lb.	—	.75 – .80
Calcium sulphate, pure	lb.	—	.25 – .30
Carbon bisulphide	lb.	.06 – .08	.09 – .10
Carbon tetrachloride, drums	lb.	.10½ – .11	.12 – .15½
Carbonyl chloride (phosgene)	lb.	—	.80 – 1.05
Caustic potash (see potassium hydroxide)		—	
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .07	.08 – .09
Chloroform	lb.	.28 – .29	.30 – .31
Cobalt oxide	lb.	—	2.00 – 2.05
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	—	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		—	—
Epsom salt (see magnesium sulphate)			
Formaldehyde, 40 per cent (nominal) †	lb.	.38 – .40	.90 – 1.00
Glauber's salt (see sodium sulphate)		—	
Glycerine	lb.	—	.24½ – .26
Iodine, resublimed	lb.	—	4.10 – 4.30
Iron oxide, red	lb.	—	.03 – .20
Iron sulphate (copperas)	cwt.	1.20 –	1.25 – 1.75
Lead acetate, normal	lb.	.12 – .13	.14 – .23
Lead arsenate (paste)	lb.	—	.13 – .17
Lead nitrate, crystals	lb.	—	.70 – .80
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	—	1.50 –
Magnesium carbonate, technical	lb.	—	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	3.40 – 3.55	3.60 – 3.75
Magnesium sulphate, commercial	100 lb.	3.00 – 3.10	3.10 – 3.25
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.16 – .17	.17½ –
Phosgene (see carbonyl chloride)		—	
Phosphorus, red	lb.	—	.60 – .65
Phosphorus, yellow	lb.	—	.55 – .77
Potassium bichromate	lb.	.32 – .33	.34 – .37
Potassium bitartrate (cream of Tartar)	lb.	—	.56 – .60
Potassium bromide, granular	lb.	—	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.26 – .27	.28 – .30
Potassium chlorate, crystals	lb.	.16 – .20	.21 –
Potassium hydroxide (caustic potash)	lb.	.25 – .32	.35 – .42
Potassium iodide	lb.	—	3.35 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	—	$0.65 – $0.95

† See New York market letter.

		Carlots	Less Carlots
Potassium prussiate, red	lb.	1.00 – 1.05	1.10 – 1.20
Potassium prussiate, yellow	lb.	.34 – .36	.40 – .70
Potassium sulphate	ton	$225.00 –	—
Rochelle salts (see sodium potas. tartrate)		—	—
Salammoniac (see ammonium chloride)		—	—
Sal soda (see sodium carbonate)		—	—
Salt cake	ton	21.00 – 22.00	—
Silver cyanide (nominal)	oz.	—	1.25 –
Silver nitrate (nominal)	oz.	—	.77 – .82½
Soda ash, light	100 lb.	2.50 – 2.60	— 3.00
Soda ash, dense	100 lb.	2.70 – 2.75	— 3.10
Sodium acetate	lb.	.06½ – .07	.07 – .08
Sodium bicarbonate †	100 lb.	2.40 –	2.75 – 3.00
Sodium bichromate	lb.	.33 – .34	.35 – .36
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powdered	lb.	.05½ – .06½	.07 – .07½
Sodium borate (borax) †	lb.	.08½ – .08½	.09 – .09½
Sodium carbonate (sal soda) †	100 lb.	1.25 – 1.35	1.40 – 1.50
Sodium chlorate	lb.	.10 –	.12 – .14
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.14 –	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	5.00 – 6.00	6.10 – 6.25
Sodium hyposulphite	lb.	—	.03½ – .04
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite †	lb.	—	.50 – .60
Sodium peroxide, powdered	lb.	—	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.40 – .42	.43 – .45½
Sodium prussiate, yellow	lb.	.23 – .29	.30 – .40
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02½ – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.05 – .06
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.15 – 1.50	1.60 – 2.00
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	—	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 –
Sulphur chloride	lb.	.05½ –	.06 –
Sulphur, crude	ton	22.00 –	—
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ –	.46 – .50
Tin oxide	lb.	.50 – .60	.65 –
Zinc carbonate, precipitate	lb.	—	.20 –
Zinc chloride, gran.	lb.	.13 –	.13½ – .15
Zinc cyanide	lb.	.49 –	.50 – .60
Zinc dust	lb.	.11½ – .12½	.13 – .15
Zinc oxide, U. S. P.	lb.	—	.19 – .21
Zinc sulphate	lb.	.03½ – .03½	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.60
Alpha naphthylamine	lb.	.40	—	.50
Aniline oil, drums extra †	lb.	.34	—	.45
Aniline salts †	lb.	.42	—	.48
Anthracine, 80% in drums (100 lb.)	lb.	.75	—	1.00
Benzaldehyde (f.f.c.)	lb.	2.00	—	2.10
Benzidine, base	lb.	1.25	—	1.35
Benzidine, sulphate	lb.	1.00	—	1.15
Benzoic acid, U.S.P.	lb.	.90	—	1.10
Benzoate of soda, U.S.P.	lb.	.80	—	1.00
Benzol, pure, water-white, in drums (160 lb.)	gal.	.27	—	.36
Benzol, 90%, in drums (100 lb.)	gal.	.25	—	.29
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech.	lb.	.25	—	.35
Beta naphthol benzoate †	lb.	.50	—	.65
Beta naphthol, sublimed †	lb.	.70	—	.90
Beta naphthol, tech. †	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.16	—	.18
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95	—	1.10
Cresylic acid, 95-97%, dark, in drums	gal.	.85	—	1.00
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.70
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.40	—	1.50
Dimethylaniline (nominal)	lb.	.95	—	1.50
Dinitrobenzol	lb.	.26	—	.37
Dinitroclorbenzol	lb.	.25	—	.30
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.32	—	.36
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.40
Diphenylamine (nominal)	lb.	.55	—	.65
H-acid (nominal) †	lb.	1.70	—	1.80
Metaphenylenediamine	lb.	1.15	—	1.80
Monochlorbenzol	lb.	.12	—	.15
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.07	—	.08
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.70	—	.85
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.30	—	.35
Nitro-toluol	lb.	.20	—	.30
Ortho-amidophenol	lb.	3.75	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	1.25
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.25	—	.45
Para-amidophenol, base	lb.	2.50	—	3.50
Para-amidophenol, HCl.	lb.	2.50	—	3.25
Para-dichlor-benzol	lb.	.12	—	.18
Paranitraniline	lb.	1.00	—	1.35
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.15	—	3.00
Paratoluidine	lb.	1.75	—	2.50
Phthalic anhydride	lb.	.65	—	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.25
Pyridin	gal.	2.00	—	2.50
Resorcin, technical	lb.	4.25	—	4.50
Resorcin, pure	lb.	6.50	—	6.75
Salicylic acid, tech., in bbls. (110 lb.) †	lb.	.45	—	.50
Salicylic acid, U. S. P. †	lb.	.55	—	.60
Salol	lb.	.90	—	1.00

Solvent naphtha, water-white, in drums, 100 gal.	gal.	$0.22	—	$0.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	...
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	...
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	† lb.	$0.38	—	$0.40
Beeswax, refined, yellow	† lb.	.40	—	.41
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1. (nominal)	lb.	.80	—	.88
Carnauba, No. 2, regular (nominal)	lb.	.65	—	.78
Carnauba, No. 3, North Country (nominal)	† lb.	.43	—	.45
Japan	lb.	.17	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	....	—	.10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	....	—	.10½
Paraffine waxes, refined, 118-120 m.p.	lb.	....	—	.08
Paraffine waxes, refined, 128-130 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 133-135 m.p.	lb.	....	—	.13
Paraffine waxes, refined, 135-137 m.p.	lb.	....	—	.14
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.940	gal.	$1.65
Pine oil, pure, dest. dist.	gal.	...
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.47
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	†280 lb.	$17.50	—	$18.00
Rosin E-I	280 lb.	17.50	—	19.00
Rosin K-N	280 lb.	19.45	—	21.00
Rosin W. G.-W. W.	280 lb.	22.00	—	22.50
Wood rosin, bbl.	280 lb.	15.50	—	17.50
Spirits of turpentine	gal.	....	—	2.20
Wood turpentine, steam dist.	gal.	....	—	2.15
Wood turpentine, dest. dist.	gal.	....	—	1.95
Pine tar pitch, bbl.	200 lb.	8.40	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.93	—	.95
Rosin oil, second run	gal.	.96	—	.97
Rosin oil, third run	gal.	1.10	—	1.15
Rosin oil, fourth run	gal.	....	—	1.18

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.40½	—	$0.42
Upriver coarse	lb.	.30½	—	.32
Upriver caucho ball	lb.	.31	—	.32½
Plantation—First latex crepe	lb.	.48½	—	.50
Ribbed smoked sheets	lb.	.48½	—	.48½
Brown crepe, thin, clean	lb.	.45	—	...
Amber crepe No. 1	lb.	.46	—	.47

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.19	—	$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.23
China wood oil, in bbls.	lb.	.23½	—	.25
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18	—	.19½
Cocoanut oil, Cochin grade, in bbls.	lb.	.20½	—	.23½
Corn oil, crude, in bbls.	lb.	.17	—	.22
Cottonseed oil, crude (f.o.b. mill)	lb.	.17½	—	.18
Cottonseed oil, summer yellow	lb.	.18½	—	.19
Cottonseed oil, winter yellow	lb.	.22	—	.24½
Linseed oil, raw, car lots	gal.	1.84	—	...
Linseed oil, raw, tank cars	gal.	1.77	—	...
Linseed oil, boiled, car lots	gal.	1.87	—	...
Olive oil, commercial	gal.	2.50	—	3.00
Palm, Lagos	lb.	.16	—	.16½
Palm, bright red	lb.	.15½	—	.17½
Palm, Niger	lb.	.15	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.22½	—	.24
Peanut oil, refined, in bbls.	lb.	.27	—	.28
Rapeseed oil, refined in bbls.	gal.	1.70	—	...
Rapeseed oil, blown, in bbls.	gal.	1.65	—	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.18½	—	.23
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.16½	—	.20

FISH

Winter pressed Menhaden	gal.	$1.18	—	...
Yellow bleached Menhaden	gal.	1.22	—	...
White bleached Menhaden	gal.	1.25	—	...
Blown Menhaden	gal.	1.30	—	1.35

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.04½	—	.05½
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb.	....	—	...
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar (nominal)	ton	13.50	—	18.00
*Fluor spar, acid grade, lump, f.o.b. mines	net ton	30.00	—	45.00
*Fluor spar, acid grade, ground, f.o.b. mines	net ton	52.00	—	5.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Graphite, crucible, 85% carbon content	lb.	....	—	.07½
Graphite, crucible, 86% carbon content	lb.	....	—	.08
Graphite, crucible, 87% carbon content	lb.	....	—	.07
Graphite, crucible, 88% carbon content	lb.	....	—	.08½
Graphite, crucible, 89% carbon content	lb.	....	—	.08½
Graphite, crucible, 90% carbon content	lb.	....	—	.09
Graphite, crucible, 91% carbon content	lb.	....	—	.08½
Graphite, crucible, 92% carbon content	lb.	....	—	.09½
Graphite, crucible, plus 92%	lb.	....	—	.12
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	...
Shellac, orange, fine	nominal lb.	1.45	—	...
Shellac, orange, superfine	lb.	1.50	—	1.60
Shellac, A. C. garnet	lb.	1.30	—	1.35
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	20.00	—	60.00
Talc, imported	ton	60.00	—	70.00

*Nominal

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	38-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	33-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	45-50 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	—	.22
Ferro-manganese, 70-80% Mn	gross ton	170.00	—	200.00
Spiegeleisen, 16-20% Mn	gross ton	50.00	—	70.00
Ferro-molybdenum, per lb. of Mo	lb.	2.25	—	2.75
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90	—	1.10
Ferro-uranium, 35-50%, of U	lb.	7.00	—	...
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	—	7.50

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, C_2, O_3	unit	$0.70	—	$0.85
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	...
*Coke, furnace, f.o.b. ovens	net ton	6.00	—	...
Petroleum coke, refinery, Atlantic seaboard	net ton	....	—	14.00
Fluor spar, gravel, f.o.b. mines	net ton	....	—	25.00
Manganese ore, 45% Mn and over	unit	.75	—	.85
Manganese ore, chemical (MnO_2)	gross ton	80.00	—	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.25	—	6.75
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	...
Pyrites, foreign, lump	unit	.17	—	...
Pyrites, foreign, fine	unit	.17	—	...
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	...
Rutile, 95% TiO_2	lb.	.11	—	...
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	...
Monazite, per unit of ThO_2	unit	42.00	—	...

*Government prices.

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ⅞-in. and larger	100 lb.	4.20
Rivets, coneheaded for boilers, ⅞-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.85
Sheets, No. 10 blue annealed	100 lb.	4.00
Sheets, No. 28 galvanized	100 lb.	6.20

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

California

COLUSA—B. L. McCue, city clk., will soon receive bids for the construction of a filtration plant, etc. Estimated cost, $38,000.

EL CENTRO—Mr. Rice, city engr., has prepared plans for the construction of a series of settling basins 2 mi. from here. Bonds amounting to $150,000 will probably be voted upon to defray expenses of this project.

FOREST—The Kate Hardy Mining Co. plans to construct a crushing plant, etc. Estimated cost, $30,000.

SELMA—The town plans an election to vote on $65,000 bonds to construct outfall sewer and septic tank. E. P. Todd, city clk.

WILLIAMS—The Bd. Supervs. are preparing plans for the construction of a water system, cost, $22,000 and a sewage disposal system, cost, $18,800. The town will vote bonds for the project. A. Givan, Sacramento, engr.

WILMINGTON—The California Barium & Chemical Co. engaged A. C. Martin, archt., 430 Higgins Bldg., Los Angeles, to prepare plans for the construction of a group of factory buildings for the manufacture of dyes, chemical sugar and other products. Smelting equipment, etc., will be installed in same. Address James O. Sword, Higgins Bldg., Los Angeles.

Connecticut

NEW BRITAIN — Landers, Frary & Clark, Commercial St., plan to build a 1-story, 50x104-ft. manufacturing plant addition. Estimated cost, $25,000. Max J. Unkelbach, 162 Main St., archt.

Illinois

CHICAGO—The Alemite Die Casting & Mfg. Co., 341 West Chicago Ave., had plans prepared for the construction of its new plant on the northeast corner of Belmont and Washtenaw Aves.

CHICAGO—The Western Petroleum Refiners Association, 14 East Jackson Blvd., is having plans prepared for the construction of a pipeline from the Kansas, Oklahoma and northern Texas fields to terminate in a large refinery here. Estimated cost, $25,000,000.

Indiana

KOKOMO—The Como Chemical Co. is building a large plant for the production of aluminum salts and heavy chemicals. H. M. Gray, pres.

Iowa

MADRID—The city awarded the contract for the construction of a sewage disposal plant, to Ward & Weighton, 516-17 Davidson Bldg., Sioux City, at $38,125.

Kansas

SALINA—The city has awarded the contract for the construction of a sewage disposal plant, to Amerman & Snyder, at $18,390.

Louisiana

BATON ROUGE—The Constantin Refining Co., New 1st Natl. Bldg., Tulsa, Okla., has purchased a 600 acre site about 2½ mi. north of here and plans to build a 20,000-bbl. oil refinery on same. Estimated cost, $2,000,000.

MANSFIELD—The Hagan Producing & Refining Co. plans to build an oil refinery. Estimated cost, $1,000,000. Address John W. Hagan, Tulsa, Okla.

SHREVEPORT — The Associated Producing & Refining Co. has purchased a 37-acre site and plans to build a 1,000-bbl. oil refinery with an initial unit on same. Estimated cost, $100,000.

SHREVEPORT — The Great Southern Producing & Refining Co., 1007 Hume-Mansur St., Indianapolis, Ind., plans to build a 1,500-bbl. oil refinery near here. Estimated cost, $250,000.

Maine

PORTLAND—A. S. Hinds, West St., has awarded the contract for the construction of a 4-story laboratory on Forest Ave., to Blackstone & Smith, 185 Middle St. Estimated cost, $500,000.

Maryland

BALTIMORE—The Emery Steel Castings Co., 603 Continental Bldg. and 210 North Garrison Lane, is in the market for electric furnaces and complete equipment for a steel foundry. Louis J. Emery, genl. mgr.

DUKES (Adelina P. O.)—The West Virginia Paper & Pulp Co., 200 5th Ave., New York City, is having plans prepared for the construction of two 2-story paper-manufacturing buildings. Estimated cost, $300,000. Lockwood, Greene Co., 101 Park Ave., New York City, archts. and engrs.

Massachusetts

BOSTON—Boston College, 688 Boylston St., is having plans prepared for the construction of a 3-story science building. Chemical equipment will probably installed in same. Estimated cost, $150,000. Maginnis & Walsh, 100 Boylston St., archts.

FITCHBURG—The Fitchburg Paper Co., 804 Main St., has awarded the contract for the construction of a paper mill, to the Casper Ranger Constr. Co., 20 Bond St., Holyoke. Estimated cost, $400,000.

WEST DUDLEY—The Burmus Paper Co. has awarded the contract for the construction of a 2-story, 50x220-ft. manufacturing building, to the H. Wales Lines Co., 134 State St., Meriden, Conn. Estimated cost, $60,000.

WEST ROXBURY (Boston P. O.)—The town of Brookline, Water Dept., is having plans prepared for the construction of a 2-story, 40x40-ft. laboratory. Estimated cost, $25,000. Strickland & Law, Pemberton Sq., Boston, archts.

Michigan

KALAMAZOO — The Kalamazoo Sanitary Mfg. Co. is in the market for equipment for the manufacture of pottery for sanitary plumbing ware.

Montana

HARLEM—The city plans an election April 5 to vote on $45,000 bonds to construct a filtration plant, etc. C. P. Wells, 804 1st Natl. Bank Bldg., Great Falls, engr.

New Jersey

TRENTON — The Natl. Porcelain Co., Southard St., received bids for the construction of a 2-story, 51x72-ft. porcelain plant, from Hiram Hughes, 1145 Indiana Ave., $19,310; Trenton Bldg. Corp., 1430 Riverside Ave., $20,975; Edward A. Lee, 511 Tyler St., $21,000.

TRENTON—The Thermoid Rubber Co., Whitehead Rd., has awarded the contract for the construction of a 1-story, 150x200-ft. rubber mill to the N. A. Bugbee Co., 206 East Hanover St. Estimated cost, $75,000.

New Mexico

ESTANCIA—The town plans an election April 6 to vote on $10,000 bonds to construct an outfall sewer and septic tank. C. H. Calkins, engr.

New York

HARRISON—The Diana Paper Co. had plans prepared for the construction of a 60x94-ft. addition to present plant. Estimated cost, $40,000. Charles E. Eaton, 307 Sherman Bldg., Watertown, engr.

MARCY — The State Hospital Comn. Capitol, Albany, received bid March 17 for the construction of a mortuary, laboratory and tuberculosis hospital building at the Utica State Hospital, here, from the Peter Keeler Bldg. Co., 425 Orange St., Albany. $186,270.

MASSENA—The Massena Farmers' Co-operative Corp. has awarded the contract for the construction of additions and repairs at the Erwin factory to C. I. Allen. The company is in the market for milk-handling and laboratory equipment. Estimated cost, $15,000.

SCENECTADY—The Mica Insulator Co., Dock St., has awarded the contract for the construction of a 4-story, 50x130-ft. factory, and a 1-story addition to present building, to the Turner Constr. Co., 242 Madison Ave., New York City. Estimated cost, $125,000.

SYRACUSE—The Will & Baumer Co., Liverpool, plans to build a 3-story, 72x255-ft. candle factory on Liverpool Rd. Estimated cost, $200,000. Guy L. Noble, Union Bldg., archt. and engr.

WATERTOWN—The Taggart Bros. Co., 595-597 Main St., West, will build a 1-story, 67x200-ft. addition to paper mill plant. Estimated cost, $40,000. Work will be done by day labor.

Ohio

CLEVELAND—The city plans to construct a reservoir, filter house, etc. at Baldwin, cost, $2,000,000; and at East Side filter plant with necessary pumping equipment, including filter basin, etc., cost, $5,000,000. A. V. Ruggles, City Hall, engr.

CLEVELAND—The Cleveland Automobile Co., East 131st St., has awarded the contract for the construction of a 1-story, 80x80-ft. heat-treating plant on London Rd., to John Gill & Son, 1301 Citizens Bldg. Estimated cost, $60,000. Noted March 3.

Oklahoma

ADA—A. L. Brown plans to construct a large brick plant. Large deposits of the shale for making this product lie south of here. Estimated cost, $75,000.

Pennsylvania

NEW HOPE — The New Hope Paper Mills has awarded the contract for the construction of a 2-story, 60x144-ft. paper mill, to C. R. Randall, 43 North Hermitage Ave., Trenton, N. J. Estimated cost, $25,000.

Texas

TEXAS CITY—The White Oil Corp., 501 5th Ave., New York City, plans to build a 15,000-bbl. oil refinery on an 800-acre site recently acquired here. Estimated cost, $2,000,000.

Wisconsin

BURLINGTON—The Burlington Brass Wks. is having plans prepared for the construction of a 1-story, 100x140-ft. foundry. Edmund B. Funston, Robinson Block, Racine, archt. and engr.

SHEBOYGAN — The Wisconsin Textile By-products Co., Calumet Rd., is having plans prepared for the construction of a 2-story, 60x87.6-ft. addition to present building and a 60x72.6-ft. building. Estimated cost, $30,000. W. C. Weeks, Ontario Ave., archt.

British Columbia

VICTORIA—The Sidney Rubber Roofing Co., Sidney, plans to construct a factory. Estimated cost, $200,000. R. W. Mayhew, mgr.

Ontario

CHATHAM—The city will vote upon bylaw appropriating $371,000 to construct a rapid sand gravity filtration plant with chlorination apparatus. F. P. Adams, City Hall, engr.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its fifth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis. Headquarters will be at the Hotel Statler.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9 and 10. Headquarters will be at the Copley-Plaza Hotel.

THE AMERICAN ELECTROCHEMICAL SOCIETY, NEW YORK SECTION, will hold a meeting on March 26, the subject of which is "Peace Uses for War Products."

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meeting in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN PETROLEUM LEAGUE will hold a meeting in Chicago, March 26 to 29.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at Asbury Park, N. J., June 22 to 25.

THE AMERICAN ZINC INSTITUTE will hold its spring meeting May 10 and 11 at the Congress Hotel, Chicago, Ill.

THE CHAMBER OF COMMERCE OF THE U. S. announces that its eighth annual meeting will be held at Atlantic City, April 27 to 29, the subject of which will be "Increased Production."

THE CHEMICAL SOCIETY OF THE COLLEGE OF THE CITY OF NEW YORK is pleased to announce the following lectures for the spring semester of 1920 to be delivered in the Doremus Lecture Theatre: "Helium," Monday, March 29, at 4 P.M., Dr. R. B. Moore, chief chemist, U. S. Bureau of Mines (Lantern); "Romance of Leather Making," Tuesday, April 13, at 4 P.M., E. A. Brand (Lantern); "Water Supply and Drainage in War Cantonments," Wednesday, April 21, at 4 P.M., Prof. D. D. Jackson, administrative head, department of chemical engineering, Columbia University (Lantern); "Modern Coke and Gas Manufacture" (Koppers Process), Thursday, April 29, at 4 P.M., E. L. Crowe (Lantern and cinema); "Chemical Naval Warfare," Friday, May 7, at 4 P.M., Prof. James Kendall, professor of chemistry at Columbia University; "Fighting Fire—Firefoam," Friday, May 14, at 4 P.M., F. A. Epps, chief engineer, the Foamite Firefoam Co. (Experimental, cinema and lantern.)

THE CONNECTICUT VALLEY SECTION of the American Chemical Society will hold a meeting Saturday, March 27, at the Hotel Elton, Waterbury, Conn. Prof. Joseph W. Richards, of Lehigh University, will speak on "The Principles Underlying the Electrochemical Industries." The Scoville Manufacturing Co.'s laboratory will be visited after the meeting.

THE ELECTRIC FURNACE ASSOCIATION will hold a meeting in Boston April 8 to 10, together with the American Institute of Electrical Engineers and the American Electrochemical Society. The subject is "Electrically Produced Alloys and Power for Electrochemical Purposes." Headquarters will be at the Copley-Plaza Hotel.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE INTERNATIONAL MINING CONVENTION will be held in Seattle April 7 to 10.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect.

THE MINE INSPECTORS INSTITUTE OF AMERICA will hold a meeting in Cleveland, Ohio, July 13.

THE MINING SOCIETY OF NOVA SCOTIA has planned a meeting for May 4 and 5 which will be held in Glace Bay.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE PENNSYLVANIA SAFETY CONGRESS for 1920 will be held at Harrisburg, Pa., March 21 to 25 inclusive.

THE SOCIETY OF INDUSTRIAL ENGINEERS will hold its national spring convention March 24 to 26 at the Bellevue-Stratford Hotel, Philadelphia.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its spring meeting at the Hotel Waldorf and the Hotel Astor, New York City, April 12 to 16.

New Publications

GEOLOGY AND OIL POSSIBILITIES OF THE NORTHERN PART OF OVERTON COUNTY, TENN. AND OF ADJOINING PARTS OF CLAY, PICKETT AND FENTRESS COUNTIES. Bull. 24, published by the State Geological Survey, Nashville, Tenn.

BRITISH INDUSTRIAL RECONSTRUCTION AND COMMERCIAL POLICIES, by Fred W. Powell; Special Agents Series No. 193, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.; sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., 10c.

SOLID LUBRICANTS, Bull. No. 4. Department of Scientific and Industrial Research, 15 Great George St., Westminster, S. W. 1, England; price 6d net. The bulletin is a summary of existing literature and not a statement based upon actual research work.

STATE OF ILLINOIS, Department of Registration and Education, Division of the State Geological Survey, has issued Bull. No. 4, on Oil Investigations in 1917 and 1918.

INDUSTRIAL RESOURCES OF THE PHILIPPINE ISLANDS. This is a 40-page pamphlet published by the Bureau of Science, Department of the Interior of the Government of the Philippine Islands, Manila. It covers chemical technology, limestone and silicate industries, non-metallic and mineral resources, fisheries, etc.

THE MISSISSIPPI VALLEY ASSOCIATION, 10 South LaSalle St., Chicago, has issued the report of its Foreign Trading and Banking Committee in a pamphlet entitled "Foreign Trade Survey, Our Share and How to Get It." The work is submitted after four months of exhaustive research as an aid to business concerns in doing their share of the world construction program. The economic and legal aspects are presented. The Association will welcome inquiry on the subject.

FIRST ANNUAL REPORT OF THE SECRETARY OF THE STATE BUREAU OF MINES AND GEOLOGY, for the period April 20 to Dec. 31, 1919. Published by the State of Idaho, under the direction of the Bureau of Mines and Geology.

THE PRODUCTION OF COPPER, GOLD, LEAD, NICKEL, SILVER, ZINC AND OTHER METALS IN CANADA, during the calendar year 1918. Published by the Department of Mines, Ottawa.

COST REPORTS OF THE FEDERAL TRADE COMMISSION, "Copper." Published at the Government Printing Office, Washington, D. C.

BANK AND PUBLIC HOLIDAYS THROUGHOUT THE WORLD. Published by the Guaranty Trust Co., New York.

THE MINERAL INDUSTRY OF UTAH, by Robert S. Lewis and Thomas Varley; Bull. No. 12, Utah Engineering Station, Department of Metallurgical Research. Published by the University of Utah, State School of Mines, in co-operation of the U. S. Bureau of Mines. Copies may be obtained, free of charge, by applying to the Director, State School of Mines, University of Utah, Salt Lake City, Utah.

COMBINING FOR FOREIGN TRADE. Published by the Guaranty Trust Co., New York City.

THE ENGINEERING FOUNDATION has published a progress report to the United Engineering Societies outlining the work accomplished through co-operation with the National Research Council.

BIBLIOGRAPHY SERIES, published by Arthur D. Little, Inc., Boston: No. 1, Chemical Warfare, reprinted from "Special Libraries," November, 1919; No. 2, The Production of Alcohol From Sulphite Waste Liquors, reprinted from *Paper*, Dec. 3, 1919; No. 3, Industrial Research, reprinted from "Special Libraries," January, 1920.

STRATIGRAPHY AND CORRELATION OF THE DEVONIAN OF WESTERN TENNESSEE, by Carol O. Dunbar. Bull. No. 21, published by the State Geological Survey, Nashville, Tenn.

THE NORTON Co., Worcester, Mass., has published a booklet on "Little Known Facts About Grinding." These are a series of brief articles by Howard W. Dunbar treating commonplace facts concerning grinding, and reprinted from *Grits and Grinds*, the periodical of the Norton Co.

COAL RESOURCES OF DISTRICT V (Saline and Gallatin counties), by Gilbert H. Cady. Bull. No. 19 (Co-operative Mining Series), published by the Department of Registration and Education, Division of the State Geological Survey, Urbana, Ill.

THE U. S. COUNCIL OF NATIONAL DEFENSE has published a booklet which is entitled "Readjustment and Reconstruction Information."

NEW U. S. TARIFF COMMISSION PUBLICATIONS: Tariff Information Series No. 15, Costs of Production in the Dye Industry 1918-1919; No. 13, The Acids of Paragraph 1 and Related Materials Provided for in the Tariff Act of 1913. A general economic survey of the industries producing citric, oxalic, formic, lactic, gallic, boric and tartaric acids.

NEW FEDERAL BOARD FOR VOCATIONAL EDUCATION PUBLICATIONS: Bull. No. 39, Coal-Mine Gases; Bull. No. 43, The Labor Audit, a Method of Industrial Investigation.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: I: 11, Gold, Silver, Copper, Lead, and Zinc in the Eastern States in 1918, by James M. Hill (Mineral Resources of the U. S., 1918, Part I), published Jan. 26, 1920; I: 12, Gold, Silver, Copper, Lead and Zinc in Nevada in 1918, by V. C. Heikes (Mineral Resources of the U. S., 1918, Part I), published Jan. 27, 1920; Bull. 694, Bibliography of the Metals of the Platinum Group, Platinum, Palladium, Iridium, Rhodium, Osmium, Ruthenium, 1748-1917, by James Lewis Howe and H. C. Holtz; Bull. 705, Conservation Through Engineering, by Franklin K. Lane, which is an extract from the Annual Report of the Secretary of the Interior.

NEW BUREAU OF MINES PUBLICATIONS: Miners' Circular No. 22, Dangerous and Safe Practices in Bituminous Coal Mines, by Edward Steidle; Miners' Circular No. 26, Miners' Safety and Health Almanac for 1920, compiled by R. C. Williams, published in co-operation with the United States Public Health Service; Tech. Paper 232, Absorption as Applied to Recovery of Gasoline Left in Residual Gas From Compression Plants, by W. P. Dykema and Roy O. Neal; Tech. Paper 236, Abatement of Corrosion in Central Heating Systems, by F. N. Speller; Tech. Paper 237, Safe Practice in Using Wire Ropes in Mines, by O. P. Hood and R. H. Kudlich; Tech. Paper 257, Waste and Correct Use of Natural Gas in the Home, by Samuel S. Wyer; Bull. 175, Experiment Stations in the Bureau of Mines, by Van H. Manning; Bull. 181, Abstracts of Current Decisions on Mines and Mining, by J. W. Thompson; Report of Committee on Standardization of Petroleum Specifications.

NEW BUREAU OF STANDARDS PUBLICATIONS: Circular No. 87, Recommended Specifications for Zinc Oxide, Dry and Paste; Circular No. 88, Recommended Specifications for Leaded Zinc Oxide, Dry and Paste; Scientific Paper No. 331, A Relation Connecting the Derivatives of Physical Quantities, by Mayo D. Hersey; Scientific Paper No. 333, Optical Conditions Accompanying the Striae Which Appear as Imperfections in Optical Glass, by Lieutenant Commander A. A. Michelson; Scientific Paper No. 334, New Forms of Instruments for Showing the Presence and Amount of Combustible Gas in the Air, by E. R. Weaver and E. E. Weibel; Scientific Paper No. 338, Some Optical and Photo-electric Properties of Molybdenite, by W. W. Coblentz and H. Kahler; Scientific Paper No. 339, Standardization of the Sulphur Boiling Point, by E. F. Mueller and H. A. Burgess; Scientific Paper No. 341, Airplane Antenna Constants, by J. M. Cork; Scientific Paper No. 342, Reflecting Power of Stellite and Lacquered Silver, by W. W. Coblentz and H. Kahler; Scientific Paper No. 344, Spectral Photoelectric Sensitivity of Silver Sulphide and Several Other Substances, by W. W. Coblentz and H. Kahler; Scientific Paper No. 345, Measurements of Wave Lengths in the Spectra of Krypton and Zenon, by Paul W. Merrill; Scientific Paper No. 352, Thermal Expansion of Insulating Materials, by Wilmer H. Souder and Peter Hidnert; Scientific Paper No. 358, Concerning the Annealing and Characteristics of Glass, by A. Q. Tool and J. Valasek; Scientific Paper No. 359, Efflux of Gases Through Small Orifices, by Edgar Buckingham and Junius David Edwards; Scientific Paper No. 363, Preparation and Reflective Properties of Some Alloys of Aluminum With Magnesium and With Zinc, by R. G. Waltenberg and W. W. Coblentz; Tech. Paper No. 142, Materials and Methods Used in the Manufacture of Enameled Cast-Iron Wares, by Homer F. Staley; Tech. Paper No. 143, A Study of the Deterioration of Nickel Spark-Plug Electrodes in Service, by Henry S. Rawdon and A. I. Krynitzky; Tech. Paper No. 144, Properties of American Bond Clays and Their Use in Graphite Crucibles and Glass Pots, by A. V. Bleininger; Tech. Paper No. 149, Estimation of Nitrates and Nitrites in Battery Acid, by L. B. Sefton; Tech. Paper No. 154, Determination of Cellulose in Rubber Goods, by S. W. Epstein and R. L. Moore.